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INDUSTRIAL WASTE PILOT PLANT STUDY. GREAT WESTERN SUGAR COMPANY. BEET SUGAR REFINERY, BRIGHTON, COLORADO. PILOT PLANT EVALUATION OF LIME TREATMENT, SEDIMENTATION, AND CHLORINATION OF SCREENED PULP WASTE WATERS FROM BEET SUGAR MANUFACTURE

G. N. McDermott

Environmental Health Center
Cincinnati, Ohio

1949

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Industrial Waste Pilot Plant Study

GREAT WESTERN SUGAR COMPANY

Beet Sugar Refinery
Brighton, Colorado

Pilot Plant Evaluation of Lime Treatment, Sedimentation, and Chlorination of Screened Pulp Waste Waters from Beet Sugar Manufacture

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FEDERAL SECURITY AGENCY
Public Health Service
Environmental Health Center
Cincinnati, Ohio

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SYLLABUS

This report covers design, and operation, during the 1949 season, of a pilot plant for treating Faenger water and pulp press water at the Great Western Sugar Company, straight house beet sugar factory located at Brighton, Colorado. The pilot plant provided fine screening, chemical feed, mixing, flocculation, and sedimentation. Consideration was given to treatment of waters for both reuse in the process and discharge to surface waters.

The pilot plant was operated 35 sampling days on lime treatment and 6 days with chlorination. Chlorine treatment was applied only to the combined Faenger water and pulp press water, whereas lime treatment studies were made of these wastes both separately and combined. Biochemical oxygen demand reduction and suspended solids removals are summarized in Table I.

A significant finding was the benefit to be derived from fine screening. Fine screening materially reduced the concentration of the waste and yielded quantities of pulp having economic significance.

Pilot plant treatment with lime consistently removed 90 per cent of the suspended solids. Sludge from lime treatment may be expected to run 5.5 per cent solids. B.O.D. results were erratic. Under favorable conditions, a 30 per cent B.O.D. reduction by lime treatment was obtained. Jar tests with lime, using 600 ppm CaO and 30 minutes contact, reduced thermophilic bacteria densities from 1,200,000 to 18 per milliliter.

The pilot plant was operated at only one chlorine dosage rate, 50 ppm. No difficulty was experienced in maintaining chlorine residuals at doses as low as 25 ppm (Figure 3). High bacteria kills were accomplished for this

TABLE 1 - SUMMARY OF B.O.D. AND SUSPENDED SOLIDS DATA FROM PILOT PLANT STUDIES OF SCREENED PULP FAENGER WATER AND PULP PRESS WATER

Waste	Treatment	Results								
			B.O.D. 5-Day 20° C				Suspended Solids			
		Sample -24 Hr. Composites	Avg. ppm	Max. ppm	Min. ppm	Average Percent Reduction	Avg. ppm	Max. ppm	Min. ppm	Average Percent Reduction
Pulp Faenger Water and Press Water (Screened)	Lime Treatment	Untreated	1282	1720	940	26	594	970	410	91
		Treated	940	1310	605		49	75	22	
	Chlorine Treatment	Untreated	1207	1700	1010	8	585	590	580	30
		Treated	1144	1330	995		412	416	408	
Faenger Water (Screened)	Lime Treatment	Untreated	979	1260	725	36	530	600	450	90
		Treated	631	760	445		54	72	39	
Pulp Press Water (Screened)	Lime Treatment	Untreated	1708	1880	1540	26	420	470	390	89
		Treated	1308	1690	1065		40	42	37	

waste by chlorine dosages as low as 7 ppm and 10 minutes contact time in jar tests (Table 6). Chlorine treatment followed by plain sedimentation was ineffective in removal of B.O.D. and suspended solids.

These wastes are amenable to proven treatment methods. The methods investigated gave only partial treatment and a treated waste that was still highly pollutional in character. Economic consideration may be expected to influence the decision as to treatment versus reuse.

GENERAL INFORMATION

1. Organization of Pilot Plant Study

This study of beet sugar process wastes was a part of the industrial waste phase of the South Platte River Pollution Survey. The project was developed at joint conferences May 20 and 25, 1949 between representatives of Great Western Sugar Company, Colorado State Board of Health, and the U. S. Public Health Service. The Company offered to design, construct and operate a waste treatment pilot plant. The Public Health Service agreed to assist by review and comment on engineering drawings for the plant, to assist in its operation, and to provide technical personnel for analytical and engineering work in connection with its operation.

2. Dates of Project

October 14, 1949 to December 21, 1949.

3. Personnel

Personnel participating in the organization of this project, in design and operation of this pilot plant, in analytical work, in supervision, and in preparation of the final report included the following:

Great Western Sugar Company

A. R. Nees, Superintendent Research Laboratory

A. N. Bennett, Chemist, Research Laboratory

Public Health Service

H. H. Black, Chief, Industrial Waste Section

N. N. Norman, Chemist

G. N. McDermott, Assistant Sanitary Engineer

C. T. Carnahan, Public Health Engineer

4. Location of Plant

The beet sugar factory of the Great Western Sugar Company selected for the pilot plant installation is located on a tract of land adjacent to the north city limits of Brighton, Colorado. The rated capacity of this plant is 1900 tons of beets per day. The actual quantities sliced during the course of this investigation are shown in Table 3.

5. Purpose

The objectives of the pilot plant research were to:

a. Make determinations and comparisons on solids and B.O.D. removals accomplished by chemical treatment and to corroborate published data.

b. Determine optimum amounts of chemicals needed for flocculation.

c. Determine the necessity of screening wastes before treatment by coagulation and sedimentation.

d. Obtain data on sludge volumes, concentrations and composition; and investigate methods of disposal.

e. To explore reclamation and reuse of treated waste.

f. To obtain data for the possible construction of a full scale plant.

6. Definitions

Various terms which are significant in discussion of beet sugar liquid wastes are:

Battery - A group of closed vessels (cells) holding sliced sugar beets through which hot water is passed for the purpose of extracting sugar.

Pulp - Sliced sugar beets from which sugar has been extracted.

Battery Wash Water - Water directed into the cell through a hose for the purpose of flushing the cell of pulp and juice.

Pulp Water - Water dumped from the cell with the pulp, and battery wash water.

Paenger - A screen used to separate pulp and pulp water.

Paenger Water - Water draining from the pulp through the aenger.

Pulp Press Water - Water pressed from screened pulp.

Pulp Waste Waters - All those waste waters derived from the handling of the pulp.

Tailings - Small chunks of beets, beet tails, leaves, and roots removed in transporting and washing operation.

7. Wastes Studied

This project included study of the following waste types:

a. Paenger water and pulp press water combined.

b. Paenger water.

c. Pulp press water.

A Link-Belt vibrating screen, 30 X 40 mesh, was provided for screening of all Paenger water and pulp press water, including the portion diverted to pilot plant. Shredded tailings were transported to the vibrating screen along with pulp water during a portion of the test period.

PILOT PLANT DESIGN

The Great Western Sugar Company utilized material already on hand at their refineries for the main units of the pilot plant. This pilot plant was designed to treat wastes at a rate of 10 gpm. Figure 1 shows the pilot plant's essential features in operational sequence, together with

the details of the design in accompanying notes and charts. The plant is shown in photographs in Figure 2. Supplemental details of the design and functioning of each of the units are given below.

8. Flow Control and Measurement

Rate of flow to the pilot plant was controlled by various size orifices under constant head. A 90° V-notch weir was used for measurement of the inflow.

9. Chemical Feed

The flow of lime was controlled by adjusting the size of opening between a hopper and a rotating horizontal disc beneath the hopper. The lime was scraped from the disc to the waste by a stationary blade.

Hypochlorite solution (7530 ppm chlorine) was added to the weir discharge. This solution feed was controlled by means of a capillary tube on which a constant head was maintained. The tube was inserted in rubber hose which in turn was connected to the leg of a glass tee, the whole assembly being mounted on a wood float.

10. Flash Mixer

This mixer is described by notation on the drawing, Figure 1. It was operated at maximum speed. The design called for one minute retention at 10 g.p.m. flow.

11. Flocculation Tank

Use of the turbine and diffusion ring type mixer, as a flocculator, was unorthodox. It was reported that this equipment was standard for a similar operation in the beet sugar refining process. Deposition of solids was prevented by a bottom horizontal paddle. Capacity was provided to

give a coagulation period of 30 minutes at the design rate. The unit functioned satisfactorily.

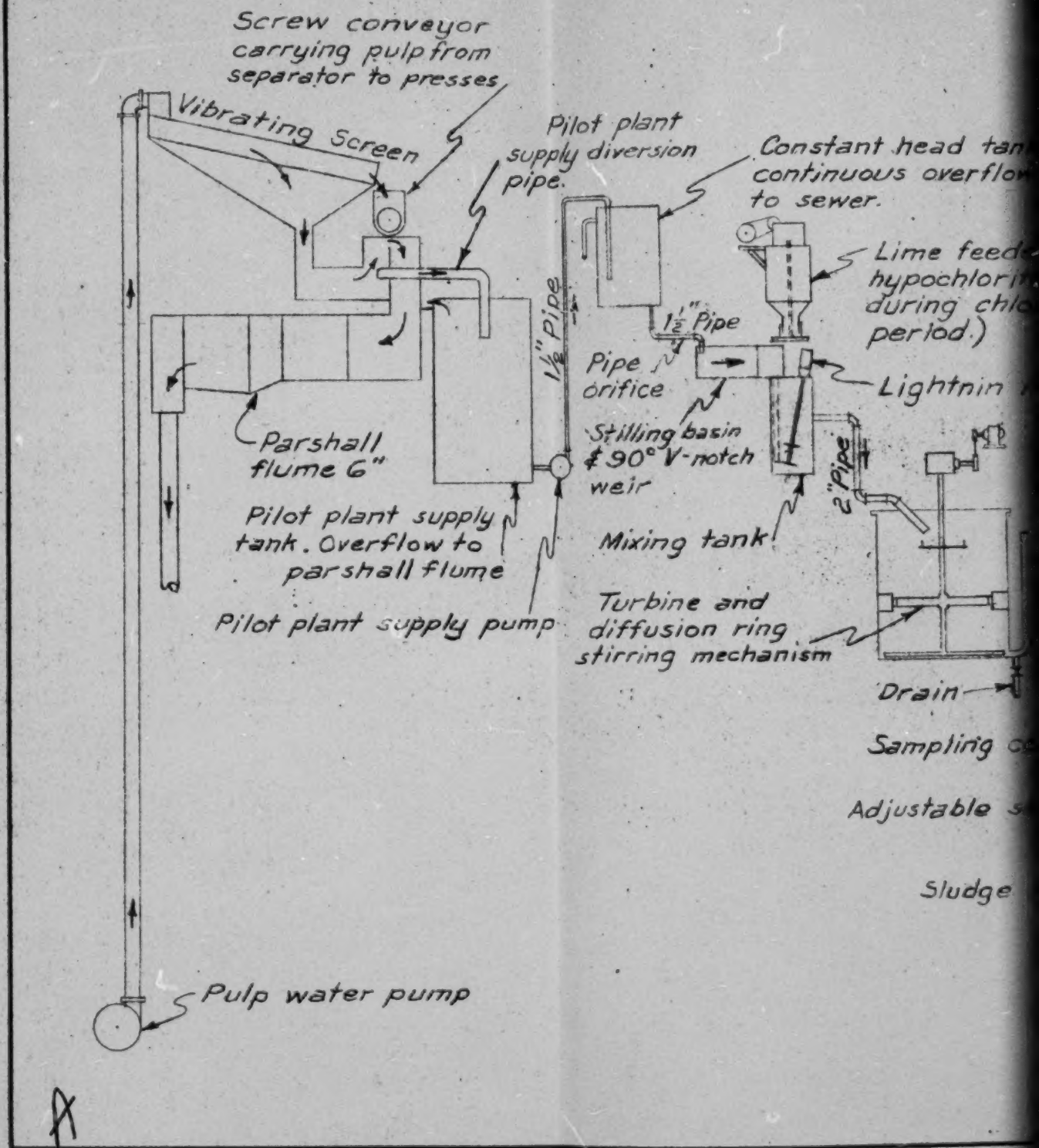
12. Sedimentation Tank

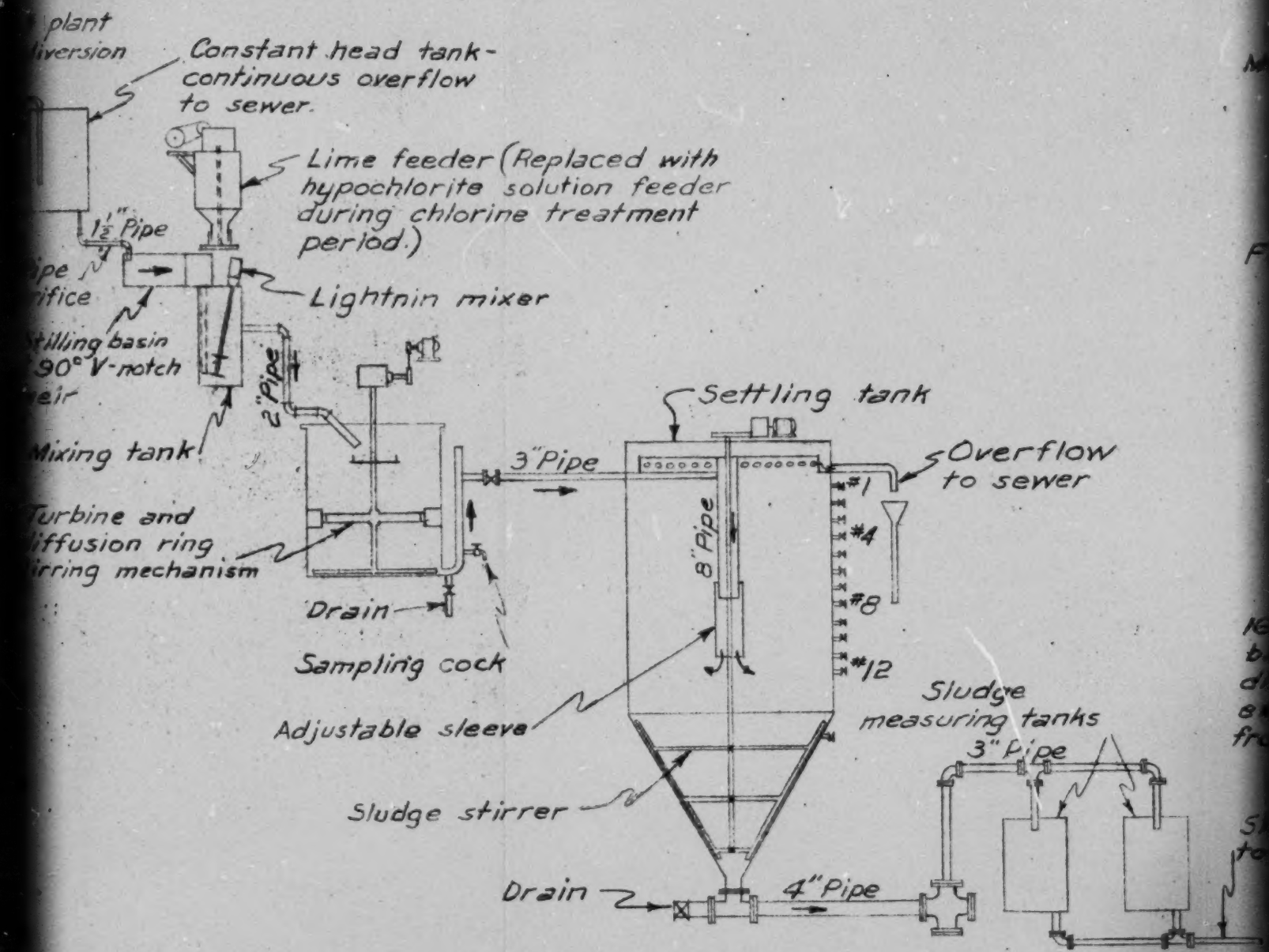
Theoretical design flow detention above the normal sludge line of the sedimentation tank was computed to be 2 hours and 10 minutes. The overflow rate was 760 gallons per square foot per day. Discharge from the tank was through 36 one-inch openings spaced five inches center to center and located in the side of the collecting trough. The sliding sleeve extension on the vertical inlet pipe permitted variation of the level at which waste was introduced. A 2 inch asbestos insulation of the sedimentation tank maintained relatively high temperatures during the settling period.

During initial operation, difficulty was experienced in withdrawing sludge. The solids accumulated on the sides of the conical bottom as a jelly-like mass of sufficient rigidity to resist flow to the sludge outlet. The result was withdrawal of thin sludge. Inability to concentrate and satisfactorily remove the sludge interfered with sedimentation and occasionally visible solids carried over with the effluent. These conditions were alleviated by installation of a slow moving (0.25 R.P.M.) stirring mechanism as shown on the line diagram, Figure 1.

13. Sludge Measuring Facilities

Sludge was measured volumetrically in 50 gallon drums, calibrated at 5 gallon intervals.


Screw conveyor carrying pulp from separator to presses
Vibrating Screen
Pilot plant supply diversion pipe.
Constant head tan
continuous overflo
to sewer.
Lime feede
hypochlorit
during chlo
period.)
1½" Pipe
1½" Pipe
Pipe orifice
Lightnin
Parshall flume 6"
Stilling basin & 90° V-notch weir
2" Pipe
Pilot plant supply tank. Overflow to parshall flume
Mixing tank
Pilot plant supply pump
Turbine and diffusion ring stirring mechanism
Drain
Sampling c
Adjustable s
Sludge
Pulp water pump
A


plant
iversion
Constant head tank-
continuous overflow
to sewer.
Lime feeder (Replaced with
hypochlorite solution feeder
during chlorine treatment
period.)
1½" Pipe
ipe
rifice
Lightnin mixer
tilling basin
90° V-notch
eir
2" Pipe
Mixing tank
Settling tank
3" Pipe
Overflow
to sewer
#1
#4
#8
#12
8" Pipe
urbine and
iffusion ring
irring mechanism
Drain
Sampling cock
Adjustable sleeve
Sludge
measuring tanks
3" Pipe
Sludge stirrer
Drain
4" Pipe

B

DESCRIPTION OF UNITS OF PILOT PLANT

VIBRATING SCREEN

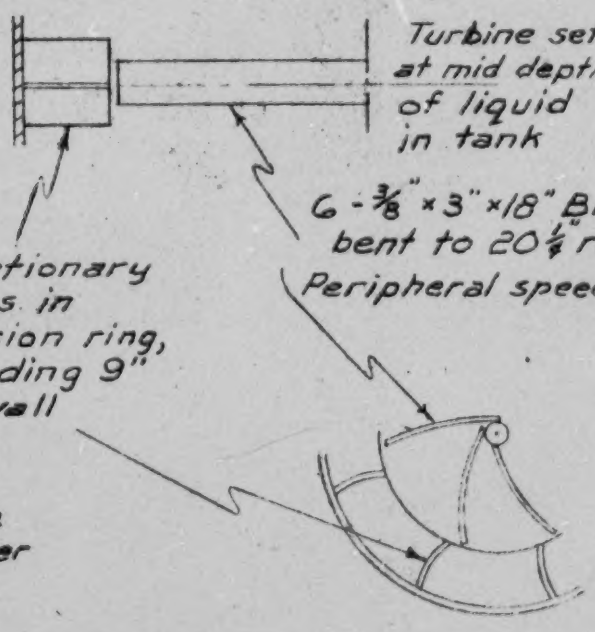
Link Belt - Type NRM-147
1800 r.p.m., 2 hp
Width of screen, 46"
Length of screen, 83½"
Area, 26.7 sq. ft.
Mesh - 30×40 - 0.015" Wire size

MIXING TANK

Cylindrical, inside dia. 14"
Liquid depth, 22½"
Capacity at overflow, 15 gallons
Stirring mechanism - Lightnin' mixer
Model CV2 - 1800 r.p.m. max.
Two 2 inch propeller blades

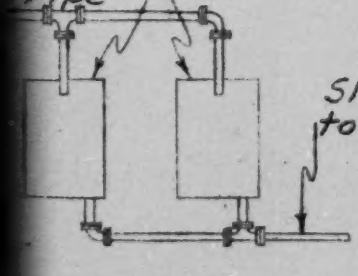
FLOCCULATION TANK

Cylindrical, dia. 4'
Liquid depth, 38½"
Capacity at overflow of
settling tank = 300 gallons
Stirring Mechanism Details


Turbine set at mid depth of liquid in tank
6 - ⅜" × 3" × 18" Blades bent to 20½" radius
Peripheral speed = 98 f.p.m.
16 Stationary blades in diffusion ring, extending 9" from wall

erflow
sewer

ge
tanks
Pipe



SETTLING TA

Cylindrica
section
Capacity o
Capacity
Capacity
sampling
Sludge Stir
2 Sets of
three ¼" ×
two ¼ × 2"
cone.
Speed - 1
Maximum

WASTE TR
BRIGHTON
GREAT WE
BRI
FEDER
PU
ENVIRO
CINCINN

C

ION OF UNITS OF PILOT PLANT

47

Wire size

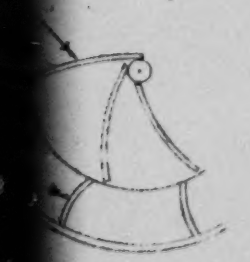
14"

15 gallons
-Lightnin' mixer
p.m. max.
blades

of
allons
Details

Turbine set
at mid depth
of liquid
in tank

" × 3" × 18" Blades
to 20½" radius
heral speed = 98 f.p.m.



SETTLING TANK
Cylindrical with conical bottom section - dia. 6'-0"
Capacity of cylindrical section, 1580 gals.
Capacity of conical section, 368 gals.
Capacity from surface to No. 12 sampling cock (sludge level) 1320 gals.
Sludge Stirrer
2 Sets of blades consisting of three ¼" × 2½" horizontal bars and two ¼ × 2" bars paralleling sides of cone.
Speed - 1 rev. in 4 minutes
Maximum peripheral speed = 4.5 f.p.m.

FIGURE 1

WASTE TREATMENT PILOT PLANT
BRIGHTON BEET SUGAR FACTORY
GREAT WESTERN SUGAR COMPANY
BRIGHTON, COLORADO

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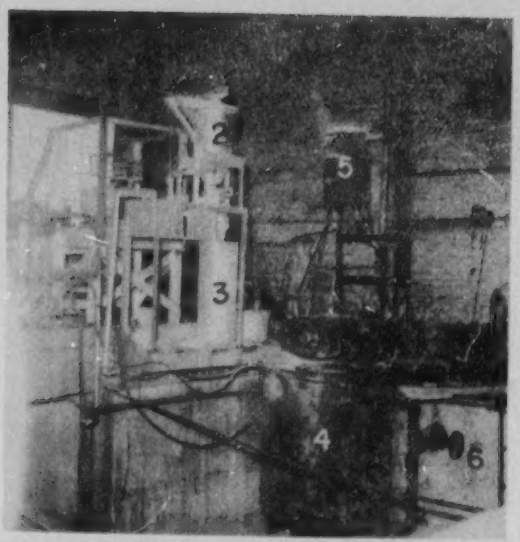

View A

1. Weir Box
2. Lime Feeder
3. Mixing Tank
4. Flocculating Tank
5. Constant head tank on supply line
6. Settling Tank

View B

1. Mixing Tank
2. Flocculator Tank
3. Settling Tank

View C

Lime Feeder and Weir Box

FIGURE 2. PILOT TREATMENT PLANT

LIME TREATMENT

The shop fabricated lime feeder did not permit accurate control of lime feed. In fact, variations of lime dosage were as much as ± 25%. Excess of lime was used to insure a sufficient dose for optimum flocculation of the waste. The Great Western Sugar Company was not concerned with the determination of the minimum dose as the cost of lime to them, even at full scale treatment, would not warrant close control.

14. Action of Lime in Pulp Water

Lime in sufficient quantities in pulp water produces prodigious quantities of loose textured, light tan floc. The sugar beet contains an appreciable quantity of pectin. The reaction of the calcium ion with pectin substances produces an insoluble calcium pectate precipitate. An attempt was made to determine the concentration of pectin in a sample of combined pulp flenger and press water. The result for this sample showed a pectin content of 412 ppm in screened pulp flenger and press water.

15. Jar Studies of Coagulation

a. Chemicals - Jar tests performed with the aid of a variable speed laboratory stirring device indicated that doses of lime in the neighborhood of 400 ppm CaO were necessary to produce optimum flocculation of pulp flenger and pulp press water.

The coagulating properties of alum and of ferric chloride in the waste were also investigated. These chemicals produced results which indicated that they could not compete with lime for treatment of this waste.

b. Flocculation Time - The time of flocculation in the pilot plant was not independently variable, therefore laboratory investigations concerning the optimum flocculation time were carried out. These tests were necessarily performed in jars which simulated conditions of the flocculation tank. At lime doses of 500 ppm CaO, the tests indicated that six minutes and in some cases four minutes of flocculation produced as much defecation of the waste as did periods of flocculation up to the maximum tested, 25 minutes. The properties of floc for both flocculation periods were comparable.

c. Return Sludge - Investigations were made in jar tests to determine if the return of sludge to the flocculation tank would permit the use of reduced lime doses. The reduction of the necessary lime dose accomplished by return of sludge proved to be relatively slight. Even with the return of 3 times the normal volume of sludge produced (6% of inflow), 300 ppm CaO were still required.

16. Test Conditions

The variables of the six runs of the pilot plant during lime treatment are given in Table No.2. The important differences in the runs were (1) type of waste treated and (2) changes in rate of inflow. The lime dose was maintained in excess of that required and was not purposely varied.

TABLE 2 - TEST CONDITIONS - LIME TREATMENT

Test No.	Period of Test (inc.)	Sampling Days	Waste Treated	Average Rate of Inflow to Treatment Plant in gpm	Theoretical Retention Minutes			Overflow Rate of Settling Tank in Gallons Per Day Per Sq. Ft.	Average Lime Dose ppm CaO
					Mixer	Flocculator	Settling Tank		
1	Oct. 16-Nov. 7	13	Screened pulp faenger and press water with tailings[a]	11.3	1.3	25.2	111	605	600
2	Nov. 9-Nov. 14	5	Same as Test No.1	20	0.75	15	66	1020	650
3	Dec. 16-Dec. 19	3	Same as Test No.1	15.7[b]	1	19	84	800	820
4	Nov. 16-Nov. 21	5	Screened pulp faenger and press water without tailings[c]	11.5	1.3	24	115	580	670
5	Nov. 23-Nov. 28	4	Screened pulp faenger water	11.4	1.3	26	116	580	690
6	Nov. 30-Dec. 5	5	Screened Pulp Press Water	10.7	1.4	28	123	545	820

Notes: a. "With Tailings" refers to practice at the factory of using the combined pulp waters as a suspension media for transporting tailings from the tailing shredder to the vibrating screen (See text for details). Such practice was discontinued during Tests Nos. 4, 5, and 6, hence "Without Tailings."

b. Flow varied between 14.0 and 17.6 gpm.

c. Combination consists of: 58% Faenger Water
42% Pulp Press Water

17. Control Tests

The table below shows the tests used to check proper operation of the plant during the experimental runs with lime treatment.

Test	Purpose	Frequency	Test Points
Alkalinity (Phenolphthalein)	Control of lime dosage	Hourly	Mixing tank outlet Settling tank outlet
Turbidity	Functioning of flocculator and settling tank	Every 2 hours	Settling tank outlet and 1st, 4th, 8th and 12th sampling cocks
Lime Feeder Control	Control of lime dosage	(1) Hourly (2) Each shift	Wt. of lime delivered by feeder in 1 minute Total weight of lime added during shift
CaO content of lime	Control of lime dosage	Daily (discontinued after first 3 weeks)	Composite samples of lime fed to process

Turbidity values for the screened scenger and pulp press water combined averaged 1200 ppm. The lime treated waste usually ranged in turbidity between 8 and 16 ppm.

The pH of the fresh untreated waste was in the range 7.2 to 7.6. A lime dosage of 500 ppm raised the pH to 11.5 and when 800 ppm lime were used the effluent pH reached 12.0.

The practice of treating with lime in excess made the pH and turbidity control tests of secondary importance.

18. Sampling Schedule

The sampling schedule as tabulated below was used for all test runs of the pilot plant. Samples were dated with that date on which the composite

was completed. Samples were iced during the compositing period.

Type of Sample	Frequency of Sampling	Compositing Period 24 hrs.	Point of Collection
Plant Inflow	Hourly	8 AM - 8 AM	Sampling cock on plant supply line
Flocculator Effluent (Discontinued after fourth week)	Hourly	8 AM - 8 AM	Sampling cock on effluent line
Settling Tank Effluent	Hourly	8 AM - 8 AM	Air gap in effluent line
Sludge	Varied	8 AM - 8 AM	From each 50 gallons drawn

CHLORINE TREATMENT

19. Jar Tests

Information concerning the chlorine dose residual relationship and the value of chlorination and sedimentation as a defecation process was obtained from laboratory experiments in order to supplement and assist in pilot plant experimentation. The tests were conducted by dosing samples in the jars of a laboratory stirring device with various chlorine doses, mixing, flocculating and settling. A constant temperature bath at the temperature of the wastes was provided for the jars. Samples were tested for residual chlorine after various contact periods and determinations made of the oxygen consumed value of the supernatant. Results obtained from these experiments on the chlorine dose-residual relationship are presented in Figure 3. The jar tests indicated no appreciable reduction in oxygen consumed value in doses to the maximum tested 250 ppm.

20. Test Conditions

One pilot plant test run with treatment by chlorination was carried out under conditions given below:

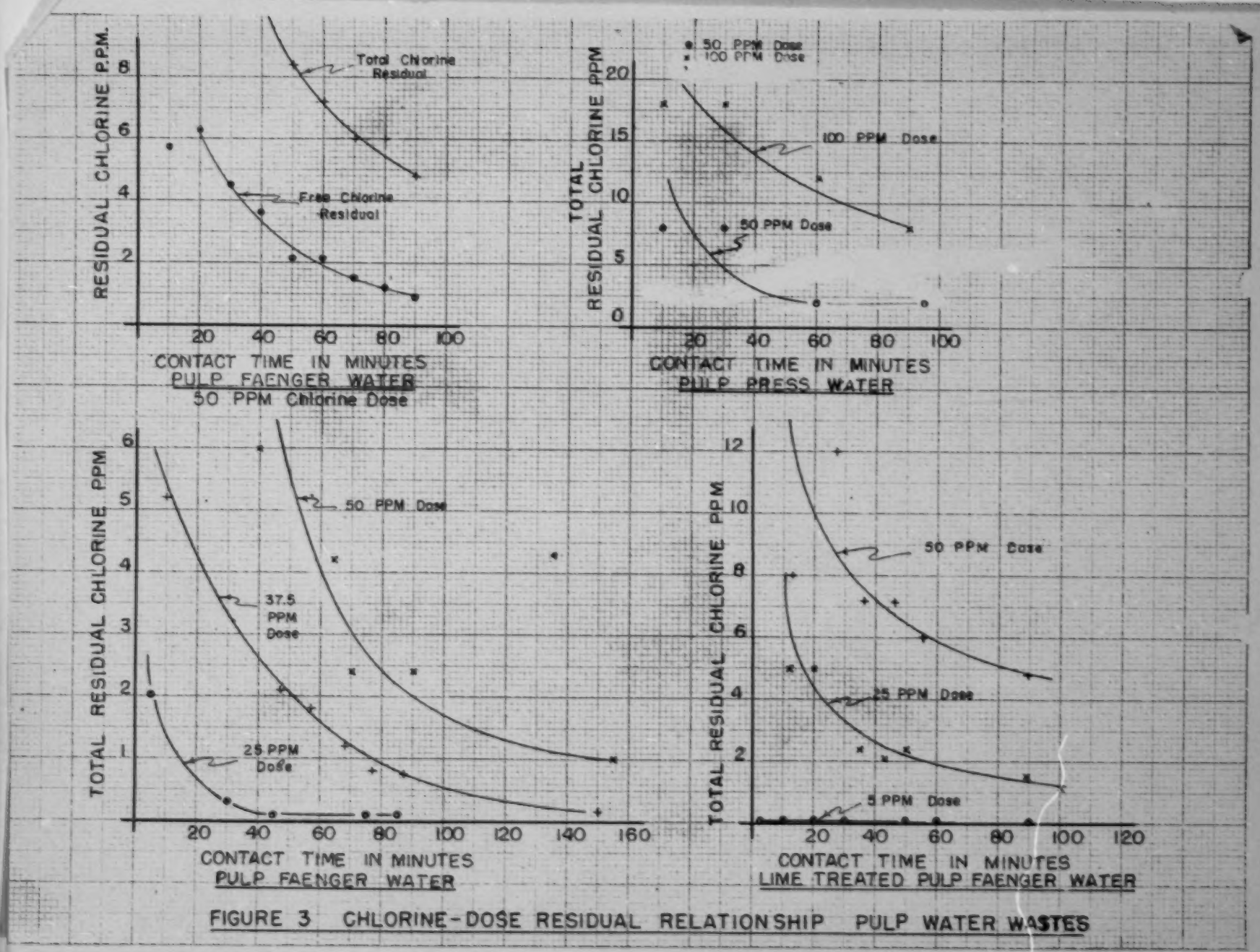

FIGURE 3 CHLORINE-DOSE RESIDUAL RELATIONSHIP PULP WATER WASTES

a. Test No. 7

Period of Test	Dec. 7 - Dec. 14 (6 sampling days).
Waste Treated	Screened combined faenger and pulp press water which had been used to transport shredded tailings.
Rate of Inflow	10.5 gallons per minute.
Theoretical Retention	
Flash Mix	1.4 minutes.
Flocculator	28 minutes.
Settling Tank	2 hours 6 minutes.
Overflow Rate of Settling Tank Based on Full Cross Sectional Area	534 gal. per day per sq. ft.
Chlorine Dose	50 ppm chlorine (solution of calcium hypochlorite).

21. Control Tests

The proper operation of the pilot plant during the chlorination test period was checked each hour by determining the volume of hypochlorite solution delivered by the feeder in one minute. Also the chlorine residual was determined colorimetrically in samples of the effluent of the pilot plant each hour. The chlorine residuals present in the effluent were usually within the range of 3 to 6 ppm.

22. Sampling Schedule

The sampling was carried on in the same manner as with the lime test runs as described in Section 16.

SPECIAL STUDIES

23. Quantity of Pulp Water Wastes

Information obtained on the volume of flow of pulp water wastes is presented in Table 3.

The daily average flows of combined fanger and press water are averaged in two groups, those "with tailings" and those "without tailings." These expressions are explained in foot-note "A" of Table No.2, page 13. The reason for doing this was to determine if any appreciable amount of wash water was passing over the tailing screen and entering the pulp water with the shredded tailings. It was observed that this was taking place to some extent; the measurement showed, however, that the quantity of wash water entering the pulp water was negligible.

Inadequate equalizing tank capacity caused substantial variations of flow through the Parshall flume. Information obtained concerning the nature of release of the waste is tabulated below:

Rate of cell dumping	14 to 16 per hour or one about every 4 minutes
Time for cell to empty into pit ...	About 15 seconds
Length of period of washing cell ..	75 to 105 seconds
Length of period of delivery of pulp suspension from one cell to fanger	About 120 seconds
Delivery of pulp press water to equalizing tank	Steady

24. Recovery of Pulp from Pulp Waste Water by Fine Screening

Pulp waste water, including shredded tailings, contained visible quantities of screenable solids. Recognizing this potential pulp recovery, the Company installed, during the summer of 1949, a 30 X 40 mesh Link-Belt vibrating screen

TABLE 3 - QUANTITY OF PULP WATER WASTES - BRIGHTON BEET SUGAR FACTORY

Type of Waste	Date Day Ending at 8 AM	Daily Average Quantity of Waste in Sec.Ft.	Tons of Beets Sliced on Date	Gallons of Waste per ton of Beets
	10/28	1.13	1885	387
	10/29	1.28	1879	440
Combined	10/30	1.21	1777	440
Pulp	11/1	1.32	1853	460
Faenger	11/2	1.22	1837	430
and	11/3	1.18	1883	405
Pulp	11/4	1.25	1876	430
Press	11/5	1.14	1896	389
Water	11/6	1.20	1883	411
With	11/7	1.12	184 :	392
Tailings	11/8	1.26	1876	434
	11/9	1.20	1824	425
	11/10	1.20	1865	416
	11/11	1.20	1875	414
	11/12	1.35	1930	452
	12/6	1.27	1869	440
	12/7	1.30	1911	440
	12/8	1.16	1629	460
	12/9	1.22	1903	414
	12/13	1.22	1840	429
	12/14	1.22	1865	423
	12/16	1.10	1661	428
	12/17	1.15	1872	397
	12/18	1.15	1864	399
	12/19	1.10	1837	387
	12/20	1.12	1848	388
	12/21	1.12	1862	389
	Avg.	1.20	1850	419

Type of Waste	Date Day Ending at 8 AM	Daily Average Quantity of Waste in Sec.Ft.	Tons of Beets Sliced on Date	Gallons of Waste per ton of Beets
Combined Pulp Faenger & Pulp Press Water Without Tailings	11/16	1.22	1891	416
	11/17	1.22	1869	422
	11/18	1.16	1678	447
	11/19	1.26	1757	464
	Avg.	1.21	1799	437
Pulp Faenger Water Only	11/26	0.625	1826	221
	11/27	0.690	1842	242
	11/28	0.740	1849	258
	Avg.	0.685	1839	240
Pulp Press Water Only	11/29	0.58	1855	202
	11/30	0.54	1867	187
	12/1	0.52	1940	173
	12/2	0.54	1970	177
	12/3	0.50	1933	167
	12/4	0.50	1887	171
	12/5	0.50	1775	182
	Avg.	0.53	1890	180

of sufficient capacity to handle all pulp waste water from the Brighton factory.

The maximum rate of flow of pulp waste water approached the capacity of the screen. Wastes were handled by the screen at rates as high as 22 gallons per square foot per minute. Reduction of waste velocity entering the screen should increase its capacity. The original screen was replaced about midway through the campaign because of a rip in the fabric, which greatly impaired its efficiency. The replacement screen fabric also developed a tear near the end of the season. The reason for these breaks in the fabric was not determined.

Reference is made to Table 4 in which are recorded estimated pulp recovery data at different periods throughout the campaign. These data indicate a minimum feed recovery of 5 pounds dry solids per ton of beets sliced. It is known that the pulp presses passed more suspended solids during the last part of the season than during the first. This condition is reflected in the dry solids per ton of beets in the pulp water during the period November 17 to 19 inclusive as compared with October 26 and November 1. This is further significant in that tailings were diverted during the November 17 to 19 period. The data referred to above were determined by passing gallon samples of unscreened waste through a No.30 screen.

Some information was obtained concerning the tailings by diverting them from the shredder for an 18 day period. This afforded an opportunity to determine the effect of tailings on the B.O.D. of the pulp water as well as to check the pulp which they represented. The tailings had no noticeable effect on the B.O.D. of the pulp water. Average wet weight and the sugar content of tailings during the test period were:

Wet tailings produced daily ..... 11.4 tons

Wet tailings per ton of beets sliced ..... 12 pounds

Average sugar content of tailings 8.5%

TABLE 4 - SOLIDS REMOVED BY FINE SCREENING OF PULP FAENGER AND PULP PRESS WATER

Waste	Date Day Ending 8 AM	Dry Solids Screened from Pulp Water ppm	Dry Solids Screened from Pulp Water in Pounds per 1000 Gallons	Waste Per Ton of Beets Sliced (From Table 3) Gallons	Dry Solids Per Ton of Beets Sliced Pounds
Pulp Faenger and Pulp Press Water With Tailings[a]	10/26	1480	12.3	419[b]	5.15
	11/1	1320	11.0	460	5.06
	12/7	1880	15.7	440	6.90
Pulp Faenger and Pulp Press Water Without Tailings[a]	11/17	1800	15.0	422	6.33
	11/18	1880	15.7	447	7.02
	11/19	1860	15.5	464	7.20
Pulp Faenger Water	11/23	1090	9.1	240[b]	2.18
	11/24	1120	9.3	240[b]	2.23
	11/26	1270	10.6	240[b]	2.54
Pulp Press Water	11/29	4260	35.5[c]	202	7.16
	11/30	5600	46.6[c]	187	8.70
	12/1	5270	43.9[c]	173	7.59
	12/2	6890	57.4[c]	177	10.2

Notes: a - "With Tailings" refers to the practice of this factory of using combined pulp waters as a suspension media for transporting tailings from the tailing shredder to the vibrating screen (See Appendix "A" for details). Such practice was discontinued for some test runs, hence "Without Tailings."

b - Average figure for 27 days. Daily figure not available.

c - Not considered normal; the presses were damaged at this time.

25. Non-Sugar B.O.D. Removals

Minor removals accomplished by lime treatment, even with excellent suspended solids removal, indicated that the greater part of the B.O.D. of the waste was in solution. Chemical precipitation has limited effect on dissolved substances, however, in beet wastes it is believed that some calcium pectate would be removed.

Sugar in the pulp water would not be effected by lime treatment. The Great Western Sugar Company determined the sugar content of the waste samples by polariscope examination. The sugar determinations thus made and the computed non-sugar B.O.D. reductions are given in Table 5. Non-sugar B.O.D.'s were computed in the following manner:

Non-Sugar BOD = BOD of Sample - BOD of Sugar Content

The value of 5-day 20° BOD of sugar used in the computation was 705 ppm per 1000 ppm sugar content. This figure was obtained by the Great Western lab from tests on prepared sugar solutions. It checks fairly well with the theoretical value 763 ppm.

TABLE 5 - SUGAR CONTENT OF PULP WATER WASTES AND REDUCTIONS OF NON-SUGAR B.O.D. BY LIME AND BY CHLORINE TREATMENT

Waste	Date	Treatment	Chemical Dose CaO and Cl ppm	Sugar Content ppm	BOD of Sugar Content ppm	BOD of Untreated Waste ppm[a]	Non-Sugar BOD of Untreated Waste ppm	BOD of Treated Waste[b] ppm	Non-Sugar BOD of Treated Waste ppm	Reduction of Non-Sugar B. O. D. Per Cent
Combined Screened Pulp Faenger and Pulp Press Water Without Tailings[c]	11/16	Lime	605	650	460	1065	605	605	145	76%
	11/17		580	840	590	1170	580	880	290	50%
	11/18		655	780	550	1235	685	835	285	58%
	11/19		715	780	550	1210	660	855	305	54%
	11/21		780	970	685	1250	565	-	-	-
Pulp Faenger Water	11/23	Lime	670	590	415	1100	685	740	325	53%
	11/25		680	390	275	1030	755	605	330	56%
	11/26		695	320	225	830	605	560	335	45%
	11/28		720	450	320	865	545	590	270	50%
Pulp Press Water	11/30	Lime	810	1370	965	1540	575	1135	170	70%
	12/1		840	1400	985	1765	780	1315	325	58%
	12/2		780	1250	880	1665	785	1255	375	52%
	12/3		825	1300	915	1760	845	1305	390	54%
Combined Screened Pulp Faenger and Pulp Press Water With Tailings[c]	12/7	Chlorine	50	980	690	1060	370	995	305	18%
	12/8		50	850	600	1080	480	1330	730	
	12/9		50	980	690	1365	675	1300	610	10%
	12/10		50	810	570	1205	630	995	425	33%
	12/12		50	850	600	1020	420	1040	440	
	12/14		50	850	600	1215	615	1070	470	24%
	12/16	Lime	775	1040	735	1490	755	955	220	71%
	12/19		770	1110	780	1420	640	810	350	48%

a. Great Western Lab Results - 24 hr. composite of pilot plant inflow.
b. Great Western Lab Results - 24 hr. composite of pilot plant effluent.
c. See foot-note "a" of Table No.2 for explanation

26. Thermophilic Bacteria in Pulp Water

The control of thermophilic bacteria in Paenger water and pulp press waters is an important consideration in reuse of the water. The significance of the information obtained by the experiments described in this section are discussed in Section 39 of this report entitled "Reclamation and Reuse."

The information presented herein concerning the density of thermophilic organisms was obtained by plating the samples in nutrient agar and incubating the plates for 24 hours at 50°C. This work was done on grab samples which were immediately plated and incubated. These results are shown graphically in Figures 4 and 5 and in Table 6.

The bacterial kill accomplished by 50 ppm chlorine treatment of screened pulp water entering the pilot plant is recorded in curves Nos. II and III, Figure 4. Samples, from which curve No.I was prepared, were taken immediately following the vibrating screen. Curve No.III represents the screened waste after it had been subjected to further contamination in passing through a small storage tank, pump, and waste supply line.

Table 6 records the survival time of thermophilic organisms in screened pulp water with various chlorine dosages as determined by jar tests. Lime treatment by 600 ppm CaO in jar tests gave equally satisfactory results.

The densities of thermophilic organisms in the pilot plant effluent during lime treatment were also determined on a few samples. Results were comparable to those obtained by jar tests with lime treatment.

A few determinations were made of the density of thermophilic organisms in battery supply water, in the juice at several points along the diffusion battery, and in the raw juice. The results are shown in Figure 5. Of particular interest in this study is the fact that the battery supply water

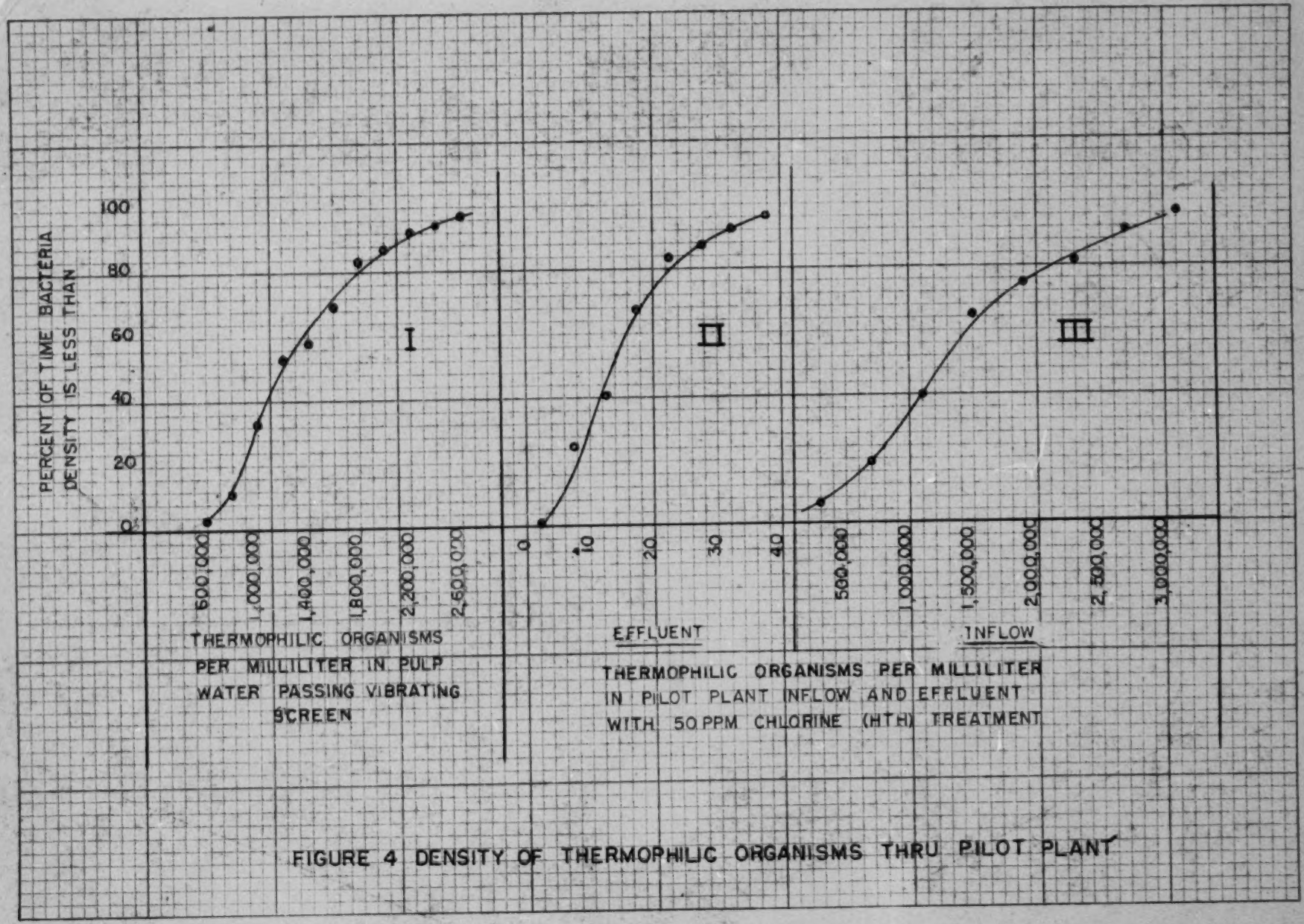

FIGURE 4 DENSITY OF THERMOPHILIC ORGANISMS THRU PILOT PLANT

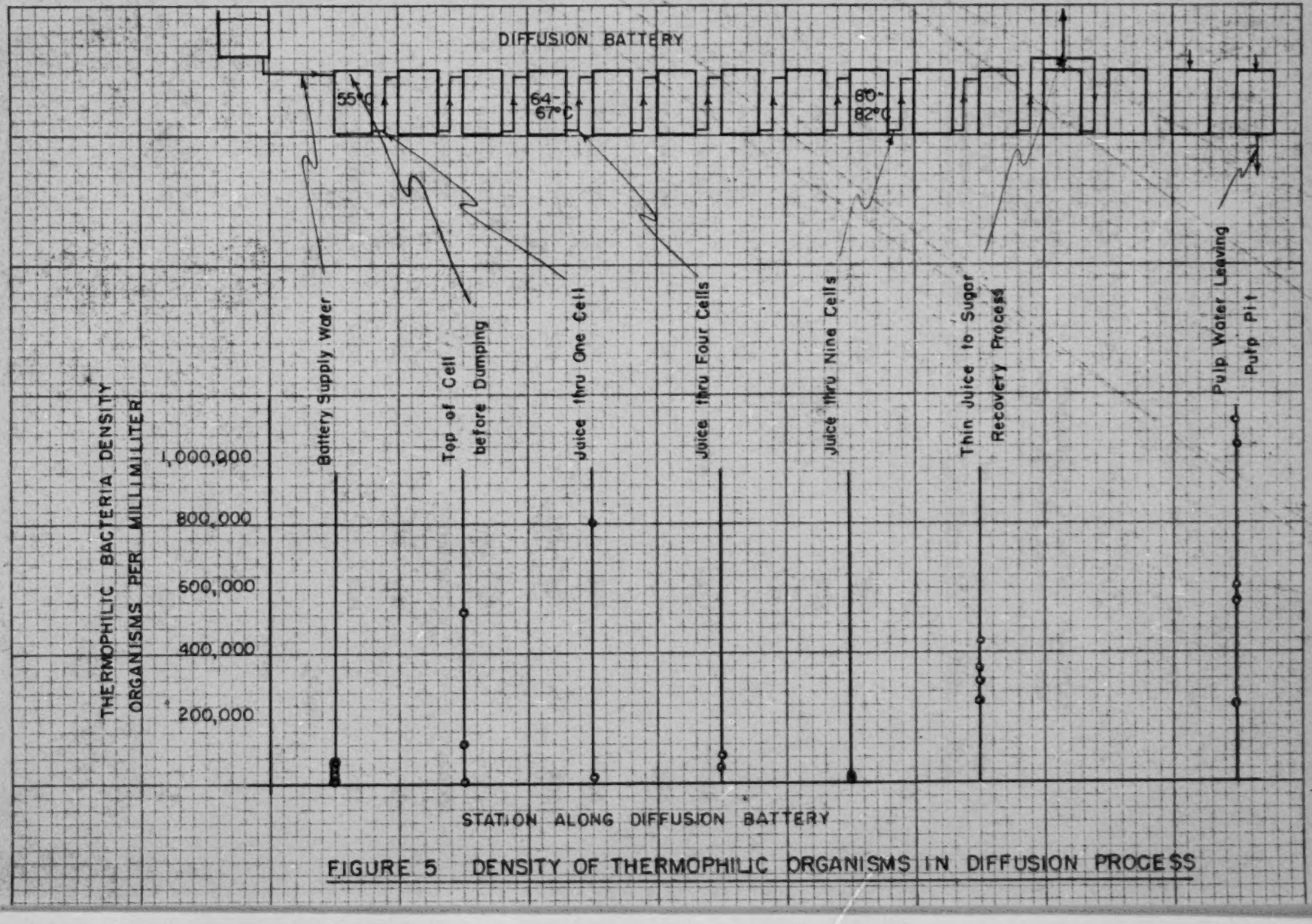

FIGURE 5 DENSITY OF THERMOPHILIC ORGANISMS IN DIFFUSION PROCESS

TABLE 6 - SURVIVAL OF THERMOPHILIC ORGANISMS IN SCREENED PULP WATER FOLLOWING CHLORINATION AND FOLLOWING LIME TREATMENT (JAR TESTS)

Chlorine Dose ppm	Thermophilic Organisms Per Milliliter in Screened Pulp Water Before Treatment	Thermophilic Organisms Remaining After Following Contact Periods							
		2 min.	10 min.	15 min.	18 min.	20 min.	30 min.	40 min.	60 min.
40	1,100,000		11				5		5
40	1,200,000		23				262		-
40	2,200,000			329			800		-
24	1,100,000		15						
23	2,200,000		-		344		2450		68
23	2,700,000		49				-		558
15	2,600,000		190				136		40
15	1,200,000		380			180	730	-	700
8	1,100,000		-			-	33	-	
8	2,200,000					240000	200000		160000
7	580,000		11			30	7		6
7	1,100,000		1100			45	600		41
7	1,300,000	9000		5900				15000	
Lime Dose ppm CaO									
600	1,200,000						18		6
600	1,100,000						13		16
600	2,200,000								4

was shown to contain as many as 57,000 thermophilic organisms per milliliter. This contamination evidently results from the use of condenser water for battery supply water. Since this quantity of bacterial contamination of the battery supply water is apparently not causing any trouble it would appear that this number of organisms is permissible in reused pulp water. The progressive raising of the temperature of the juice as it passes through the battery to 80°C evidently greatly reduces the concentration of bacteria in the juices.

EXPLANATION OF ANALISES

27. Biochemical Oxygen Demand (BOD)

The biochemical oxygen demand of sewage or industrial waste is the amount of oxygen required during stabilization of the organic matter by aerobic bacterial action. Since this is a phenomenon into which both time and temperature enter, a standard set of conditions (5 days, 20°C) is universally used for the test. For normal domestic sewage and some industrial wastes approximately 68 per cent of the oxygen requirement of the carbonaceous material present is normally satisfied during the standard test. For industrial wastes with certain characteristics different from domestic sewage this per cent satisfied during the test may differ considerably.

28. Oxygen Consumed from Permanganate

The oxygen consumed is the amount used by a sample when digested for 30 minutes in a boiling water bath with a definite strength of permanganate. A part of the carbon but not the nitrogen in organic matter is oxidized in the test. It is of value in estimating the strength of certain industrial wastes and sewages or in conjunction with the determination of the B.O.D.

29. Solids

Solids analyses include those for total solids, suspended solids, and the volatile constituents of each. Total Solids consist of the solids present in a liquid, the term includes both suspended solids and dissolved solids. Suspended Solids are solids that either float on the surface of, or are in suspension in water, sewage, or other liquids, and which are removed by laboratory filtering. Volatile Solids are those solids in water, sewage, or other liquids, that are lost upon ignition of the total (giving total

volatile) solids or suspended (giving suspended volatile) solids.

In industrial wastes, the quantities of solids found can seldom be correlated with biochemical characteristics of the waste such as the 5-day B.O.D. Large quantities of suspended solids may be undesirable due to physical properties, i.e., settling on the bed of the receiving body of water, with formation of sludge banks.

30. Nitrogen

Organic nitrogen and free ammonia, taken together, are an index of the organic nitrogenous matter present in a waste. Free ammonia or ammonia nitrogen is a result of bacterial decomposition of organic matter. A fresh cold waste should be relatively high in organic nitrogen and low in free ammonia. The reverse may be expected in a stale warm waste. The sum of the two should be unchanged in the same waste. The total concentration of the two is a valuable index of the strength of a waste and is significant when considering biological treatment.

31. pH

The symbol "pH" denotes the logarithm of the reciprocal of the hydrogen ion concentration in a given water, this symbol being a universal one in chemistry. The pH value indicates the relative acidity or alkalinity of a water or waste, being lower with higher degrees of acidity. It is a measure of intensity rather than quantity.

32. Chlorine Residual

The chlorine residual in a sample is a measure of the amount of chlorine present in chemical forms having bactericidal properties. Such chlorine may

be combined with nitrogenous compounds and ammonia or may be in the form of HOCl or OCl^-. The content of the latter forms, HOCl and OCl^-, are referred to as free chlorine. At ordinary pH ranges the free chlorine is a much more effective agent for killing bacteria than the combined.

DISCUSSION OF RESULTS

A considerable amount of data were accumulated during this study. The purpose of this section is to focus attention on results which are believed to be significant. In analyzing these data, it has been possible to offer explanations for certain results which appear inconsistent.

Analytical results for both the Public Health Service and the Great Western Sugar Company laboratories are tabulated in Table 7. Effort was made to employ identical procedures and similar techniques in the laboratory work duplicated. Analyses were made according to "Standard Methods for the Examination of Water and Sewage" (2).

Test Number	Treatment	Waste Treated	Day during at P.M.	Chemical Added per Gal. of Influent	Time to Plant	Plant In Gal.	BIOCHEMICAL OXYGEN DEMAND 5-Day - 20° PPM: Plant Influent	By P.H.S. Lab.	By G.E. Lab.	Plant Effluent	By P.H.S. Lab.	By G.E. Lab.	% Reduction	% Reduction P.H.S. Lab.	% Reduction G.E. Lab.	POUNDS OF BOD PER TON OF DRIED SHREDDED WASTE	OXYGEN CONSUMED (Permanganate) PPM: Plant Influent	By P.H.S. Lab.	By G.E. Lab.	Plant Effluent	By P.H.S. Lab.	By G.E. Lab.	% Reduction P.H.S. Lab.	% Reduction G.E. Lab.	TOTAL SOLIDS PPM: Plant Influent	Plant Effluent (f)	% Reduction	TOTAL FIXED SOLIDS PPM: Plant Influent	Plant Effluent (f)	% Reduction	TOTAL VOLATILE SOLIDS PPM: Plant Influent	Plant Effluent (f)	% Reduction	SUSPENDED SOLIDS - TOTAL PPM: Plant Influent	Plant Effluent (f)	% Reduction
1	Lime Treatment	Combined Screened Pulp Passenger and Pulp Press Water with Tailings (See note a)	10/17	500	11.9	1170	1498	920	996	21[b]	34		460	380	17	2649	2510	2444	2420	8	4	754	1076	+43	1695	1368	28	410	52	87	20	10	50			
			10/19	430	11.9	1100	1166	920	950	16[b]	19					1882	2090	2201	2020	+17	3							643	47	93						
			10/20	590	11.7	1160	1215	1070	920	[c]	24		645	710	+10	1789	2040	2384	2180	+33	+7	553	752	+36	1236	1632	9	556	60	88	32	19	41			
			10/21	445	11.9	1070	1090	1040	850	3[b]	22		630	670	+6	2063	2050	1918	1950	6	5	594	598	+1	1469	1320	10	733	61	92	120	16	87			
			10/22	555	11.5	-	1110	-	906		18						1910		2060		+8														
			10/24	695	11.6	1310	1210	1190	880	9[b]	27		800	800	0	2154	2080	2300	2160	+7	+4	568	782	+38	1586	1518	4	970	65	93	130	17	87			
			10/26	685	11.9	1460	1250	985	93	33[b]	26		850	1120	+32	2054	2300	2251	2290	+10	0	581	796	+37	1473	1455	1	790	39	95	180	17	85			
			10/27	635	11.8	1420	1160	1310	950	[c]	18		1370	1280	7	2429	2390	2179	2150	10	10	594	757	+27	1835	1422	23	820	58	93	150	15	90			
			11/2	610	12.0	1300	1230	800	860	30[b]	30	4.4	740	680	8	2154	2130	2092	2130	29	2	492	755	+35	1662	1337	20	660	43	93	150	12	92			
			11/3	625	12.0	1280	1500	1188	1340	9[b]	31	5.1	980	810	17	2570	2700	2231	2210	13	18	620	817	+24	1950	1434	28	610	34	95	110	9	92			
			11/4	650	12.0	1230	1510	940	1020	23[b]	36	5.6	960	760	21	2653		2257	2170	15		593	755	+21	2060	1502	27	560	32	94	150	10	93			
			11/5	655	12.0	-	1225		905		26	4.0					2780		2100		24														
			11/7	705	12.0	1320	1190	885	910	33[b]	24	3.9	840	620	26	2271	2390	2053	2180	10	9	586	817	+28	1685	1236	27	640	37	94	140	13	91			
			AVERAGES			1257	1258	1022	932	18[b]	26	4.6	827	783	5	2243	2281	2210	2153	2	5	593	790	+29	1685	1420	18	668	48	92	118	14	81			
2	Lime Treatment	Same as Test No.1	11/9	650	20.0	1040	1450	755	1100	27	24	5.1	680	520	24	2034	2130	1900	1920	11	10	386	674	43	1648	1226	26	490	75	84	89	21	76			
			11/10	670	20.2	940	1095	902	900	4[b]	18	3.8					2210		1980		10														
			11/11	635	20.2	-	1360	-	920		32	4.7					2550		2060		19														
			11/12	640	20.5	-	1180	-	1050		11	4.4					2260		2200		3														
			11/14	670	20.5	1610	1420	1050	1120	35	21		1040	800	23	2708	2690	2306	2240	15	17	499	724	31	2209	1582	28	460	50	89	110	8	93			
			AVERAGES			1197	1301	902	1018	22	21	4.5	860	660		2371	2368	2103	2080	13	12	443	699	37	1928	1404	27	470	62	86	103	14	83			
3	Lime Treatment	Same as Test No.1	12/16	775	17.6	1420	1490	910	955	36	36	5.3				2776	2820	2292	2250	17	20	435	738	+70	2341	1554	34	470	66	86	120	20	83			
			12/19	770	15.4	1720	1420	900	810	48	43	4.6				2668	2730	2177	2110	18	23	462	754	+63	2206	1423	35	610	44	93	190	28	85			
			12/21	910	14.0	1490	1180	1090	905	26	23	3.8				2651	2650	2493	2450	6	8	450	823	+45	2201	1670	24	440	71	84	40	55	37			
			AVERAGES			1543	1360	967	890	37	34	4.6				2698	2730	2321	2270	10	17	449	772	+59	2249	1549	31	510	60	88	120	34	68			
4	Lime Treatment	Combined Screened Passenger and Pulp Press Water Without Tailings (Note a)	11/16	605	11.8	1250	1065	755	605	40	43	3.7	880	620	30	2223	2190	1795	1820	19	17	534	681	+28	1689	1114	34	520	22	96	170	4	98			
			11/17	580	11.7	1080	1170	615	880	43	25	4.1	900	620	31	2365	2410	1811	1920	23	20	374	652	+43	1991	1159	42	520	31	94	40	3	92			
			11/18	655	11.4	1370	1235	1030	835	25	32	4.6				2398	2360	2058	1980	14	16	542	766	+29	1856	1292	30	500	37	93	130	14	89			
			11/19	715	11.4		1210		855		29	4.7							2140																
			11/21	790	11.4	1640	1250		-				960	-		2591	2770					481			2110			530			70	-	-			
			AVERAGES			1335	1186	800	796	36	32	4.3	913	620	30	2394	2430	1888	1980	19	18	483	700	+33	1911	1188	35	520	30	94	100	7	93			
5	Lime Treatment	Screened Pulp Passenger Water	11/23	670	11.4	1260	1100	760	740	40	33		680	540	21	2173	2120	1880	1870	14	12	404	695	42	1769	1185	33	540	52	90	60	9	87			
			11/25	680	11.3	1040	1030	720	605	31	41					1928	1960	1758	1820	9	7	358	691	48	1570	1067	32	600	39	97	80	2	98			
			11/26	695	11.4		830		560	-	33	1.5					1810		1730		4														
			11/28	720	11.2	725	865	445	590	39	32	1.9				1908	1910	1916	1820	0	5	368	720	49	1540	1196	20	450	72	84	90	28	69			
			AVERAGES			1008	956	642	624	37	35	1.7	680	540	21	2003	1950	1851	1810	23	7	377	702	49	1626	1149	28	530	54	90	80	13	85			
6	Lime Treatment	Screened Pulp Press Water	11/30	810	11.3	1695	1540	1690	1135	0	26	2.4	1950	1220	48	2878	2890	2619	2540	9	12	355	777	+54	2523	1742	27	390	41	90	50	15	70			
			12/1	840	10.7	1880	1765	1420	1315	25	26	2.5	2350	1500	36	2966	3070	2705	2680	9	13	349	744	+53	2617	1961	25	470	42	91	70	9	87			
			12/2	780	10.7	1740	1665	1280	1255	26	25	2.5				2890	2880	2680	2540	7	12	366	735	+50	2524	1945	23	400	37	86	20	1	95			
			12/3	825	10.4		1760		1305	-	26	2.5					2910		2670		8														
			12/5	870	10.7		1615		1065	-	34	2.5					2970	2668	2660		10														
			AVERAGES			1772	1669	1463	1215	25	27	2.5	2150	1260	42	2911	2940		2620	8	11	357	752	+53	2565	1916	25	420	40	89	50	8	84			
7	Chlorine Treatment	Same as Test No.1	12/7	50	10.4		1060		995		6	3.9				2670	2480																		
			12/8	50	10.9	1010	1080	1280	1130	+27	+19[e]	4.1				2413	2460	2797		+16		419	358	12	1994	2429	+22	580	416	28	200	104	48			
			12/9	50	10.7	1700	1365		1300		5	4 7				2855	2840	2730	2610		8	552	476	14	2303	2254	2	590	408	31	180	116	36			
			12/10	50	10.2		1205		995		17						2430		2390		2														
			12/12	50	10.4		1320		1040		+2						2400		2470		+3														
			12/14	50	10.5		1215		1070		12	4.3					2560		2280		10														
			AVERAGES			1355	1157	1280	1122	+27	8	4.2				2646	2525	2763	2440	+6	+4	496	422	13	2148	2342	+10	585	412	30	90	110	42			

NOTES:

a-'With Tailings' refers to practice at this factory of using the combined pulp waters as a suspension media for transporting tailings from the tailing shredder to the vibrating screen (see text for details). Such practice was discontinued during Tests Nos. 4, 5, and 6, hence 'without tailings.'

b-Difficulties were experienced in obtaining the best dilutions for B.O.D. tests for the designated results.

c-Not used in average.

d-Average of temperature readings taken hourly in pilot plant weir box.

e-Sub-zero weather.

f-In interpretation of the results of the solids determinations the possible errors due to the presence of lime must be recognized.

g-These values not considered typical because of sludge removal troubles experienced before installation of stirrer.

TEMPERATURE OF PULP WATER WASTES		
WASTE	Period of Average	Temperature[d] Average °C
Combined pulp passenger and pulp press water with tailings.[a]	Oct. 17 to Nov. 7	47
Combined pulp passenger and pulp press water with tailings.[a]	Nov. 9 to Nov. 14	48
Combined pulp passenger and pulp press water without tailings.[a]	Nov. 16 to Nov. 21	50
Pulp passenger water	Nov. 23 to Nov. 28	52.3
Pulp press water	Nov. 30 to Dec. 5	49
Combined pulp passenger and pulp press water with tailings.[a]	Dec. 7 to Dec. 14	43[g]

NITROGEN CONTENT OF	
WASTE	Days of Composite
Pulp Passenger Water	Nov. 23
Pulp Passenger Water	Nov. 28
Pulp Press Water	Nov. 30 thru Dec. 2

Reproduced best avail

TOTAL SOLIDS PPM									TOTAL FIXED SOLIDS PPM			TOTAL VOLATILE SOLIDS PPM			SUSPENDED SOLIDS -TOTAL PPM			SUSPENDED SOLIDS -FIXED PPM			SUSPENDED SOLIDS -VOLATILE PPM			DISSOLVED SOLIDS -TOTAL PPM			DISSOLVED SOLIDS -FIXED PPM			DISSOLVED SOLIDS -VOLATILE PPM			SETTLEABLE SOLIDS BY VOLUME ML PER LITER			SLUDGE		
PLANT INFLUENT	PLANT EFFLUENT (E) BY G.W. LAB.	PLANT EFFLUENT (E) BY P.H.S. LAB.	% REDUCTION P.H.S. LAB.	% REDUCTION G.W. LAB.	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT	PLANT EFFLUENT (E)	% REDUCTION	PLANT INFLUENT - PPM	PLANT EFFLUENT	% REDUCTION	PERCENT MOISTURE	PERCENT SOLIDS	TOTAL SOLIDS - PPM	FIXED SOLIDS - PPM	VOLATILE SOLIDS - PPM
2444	2420	8	4	754	1076	+43	1895	1368	28	410	52	87	20	10	50	390	42	87	2239	2392	+ 7	734	1066	+45	1505	1326	12							95.4	4.6	45680	23000	22680
2201	2020	+17	3							643	47	93							1239														97.2	2.8	28850	-	-
2384	2180	+33	+7	553	752	+36	1236	1632	9	556	60	88	32	19	41	524	41	92	1233	2324	+90	521	733	+41	712	1591	+123	12	0.5	96	96.6	3.6	35420	12960	22460
1918	1950	6	5	594	598	+ 1	1469	1320	10	713	61	92	120	16	87	593	45	92	1350	1857	+39	474	582	+23	876	1275	+ 46	23	0.15	99						
	2060		+8																																		
2300	2160	+ 7	+ 4	568	782	+38	1586	1518	4	970	65	93	130	17	87	740	48	94	1180	2235	+89	438	765	+75	746	1470	+ 97	9	0.2	98	94.9	5.1	50900	20600	30300
2251	2290	+10	0	581	796	+37	1473	1455	1	790	39	95	180	17	85	610	22	96	1294	2212	+75	401	779	+94	863	1433	+ 66	33	0.3	99	95.5	4.5	42800	17100	25800
2179	2150	10	10	594	757	+27	1835	1422	23	800	58	93	150	15	90	650	43	93	1659	2121	+30	444	742	+67	1185	1379	+ 16	7	0.2	97	95.0	5.0	49300	18900	30400
2092	2130	29	2	492	755	+35	1662	1337	20	660	43	93	150	12	92	510	31	94	1444	2049	+37	342	743	+117	1152	1306	+ 13									
2231	2210	13	18	620	817	+24	1950	1414	28	610	34	95	110	9	92	500	25	95	1950	2197	+12	510	808	+58	1440	1389	4	7	0	100	93.8	6.2	69220	27232	41988
2257	2170	15		593	755	+21	2060	1502	27	560	32	94	150	10	93	410	22	95	2093	2225	+ 6	443	745	+68	1650	1480	10	15	0.23	98	93.6	6.4	76610	28550	47460
	2120		24																																		
2053	2180	10	9	586	817	+28	1685	1236	27	640	37	94	140	13	91	500	24	95	1631	2016	+24	446	804	+80	1185	1212	+ 2				93.7	6.3	88620	31090	57530
2210	2153	2	5	593	790	+29	1685	1420	18	668	48	92	118	14	81	553	34	93	1573	2163	+41	475	777	+67	1131	1386	+33.7				95.0	4.9	54089	22429	34827
1900	1920	11	10	386	674	43	1648	1226	26	490	76	84	89	21	76	391	54	86	1554	1825	+17	397	653	+120	1257	1172	7	7	5	29	93.4	6.6	70130	26620	43510
	1980		10																									7.5	0.8	89							
	2060		19																									7	2.5	60							
	2200		3																																		
2306	2240	15	17	499	724	31	2209	1582	28	460	50	89	110	8	93	350	42	88	2248	2256	0	389	716	+84	1859	1540	17				93.5	6.5	80490	29100	52390
2103	2080	13	12	443	699	37	1928	1404	27	470	62	86	100	14	85	370	48	87	1900	2040	+ 8	343	684	+102	1558	1356	12	7.2	2.8	59	93.4	6.6	75310	27360	47950
2292	2250	17	20	435	738	+70	2341	1554	34	470	65	86	120	20	83	350	45	87	2306	2227	6	315	718	+128	1991	1509	24				96.1	3.9	48330	15780	24550
2177	2110	18	23	462	754	+63	2206	1423	35	610	44	93	190	28	85	420	16	97	2058	2133	+ 4	272	726	+167	1786	1407	+ 27				94.3	5.7	62880	24370	40430
2493	2450	6	8	450	823	+45	2201	1670	24	440	71	84	40	55	37	400	16	96	2211	2422	+10	410	768	+88	1801	1654	8				93.5	6.5	73450	31930	41530
2321	2270	10	17	449	772	+59	2249	1549	31	510	60	88	120	34	68	390	36	93	2192	2261	+ 3	332	737	+128	1859	1523	2				94.6	5.4	59553	24030	35500
1795	1820	19	17	534	681	+28	1689	1114	34	520	22	96	170	4	98	350	18	96	1703	1773	+ 4	364	677	+86	1339	1096	18	7	0.1	99						
1811	1920	23	20	374	652	+43	1991	1159	42	520	31	94	40	3	92	480	28	94	1845	1780	3	334	649	+94	1511	1131	25	5	0.1	98	95.2	4.8	55050	21600	33450
2058	1980	14	16	542	766	+29	1956	1292	30	500	37	93	130	14	89	370	23	94	1898	2021	+ 6	412	752	+82	1486	1269	15				95.6	4.4	46470	17000	29470
	2140																																				
				481			2110			530			70	-	-	460	-	-				411			1650			6	0	100	93.8	6.2	69400	25800	43600
1888	1980	19	18	483	700	+33	1911	1188	35	520	30	94	100	7	93	420	23	95	1815	1991	+ 2	380	693	+ 87	1496	1165	19	6	0.1	99	94.9	5.1	56970	21470	35510
1880	1870	14	12	404	695	42	1769	1185	33	540	52	90	60	9	87	480	43	91	1633	1828	+12	344	686	+100	1289	1142	11	7	0	100	94.4	5.6	54520	19940	34580
1758	1820	9	7	358	691	48	1570	1067	32	600	39	97	80	2	98	520	37	91	1328	1719	+29	278	689	+148	1050	1030	2	7.5	2	73	94.3	5.7	56910	21540	35370
	1730		4																																		
1916	1820	0	5	368	720	49	1540	1196	20	450	72	84	90	28	69	360	44	88	1459	1844	+26	278	692	+149	1180	1152	2	6.5	0.2	97	93.7	6.3	64560	26030	38530
1851	1810	23	7	377	702	46	1626	1149	28	530	54	90	80	13	85	450	41	91	1471	1797	+22	300	689		1173	1108	5	7	0.7	90	94.1	5.8	58660	22500	36160
2619	2540	9	12	355	777	+54	2523	1962	27	390	41	90	50	15	70	340	26	92	2488	2578	+ 4	305	762	+149	2183	1816	17	5	0.2	96	96.5	3.5	35950	13000	22950
2705	2680	9	13	349	744	+53	2617	1961	25	470	42	91	70	9	87	400	33	92	2496	2663	+ 7	279	735	+163	2217	1928	13	4.5	0.1	98	96.5	3.5	36770	13020	23750
2680	2540	7	12	366	735	+50	2524	1945	23	400	37	86	20	1	95	380	36	90	2490	2643	+ 6	346	734	+112	2144	1909	11	9	0.2	98	96.1	3.9	40060	14060	26000
	2670		8																																		
2668	2660		10																																		
	2620	8	11	357	752	+53	2555	1916	25	420	40	89	50	8	84	380	32	91	2491		+ 6	310	743		2181	1884	14	6.2	0.2	97	96.4	3.6	37590	13360	24230
2797		+16		419	368	12	1994	2429	+22	580	416	28	200	104	48	380	312	18	1833	2381	+30	219	264	+20	1614	2117	+ 31	7	0.5	93	96.0	4.0	42740	11230	31510
2730	2610		8	552	476	14	2303	2254	2	590	408	31	190	116	39	410	292	29	2265	2322	+ 3	372	360	3	1893	1962	36	8	0.5	94						
	2390		2																																		
	2470		+3																																		
	2280		10																																		
2763	2440	+ 6	+ 4	496	422	13	2148	2342	+10	585	412	30	90	110	42	400	302	24	2049	2334	+16	296	312	+ 8	1763	2030	2	7.5	0.5	94	96.0	4.0	42740	11230	31510

P PULP WATER WASTES			
	Period of Average	Temperature[d] Average °C	
ulp	Oct. 17 to Nov. 7	47	
ulp	Nov. 9 to Nov. 14	48	
ulp	Nov. 16 to Nov. 21	50	
	Nov. 23 to Nov. 28	52.3	
	Nov. 30 to Dec. 5	49	
ulp	Dec. 7 to Dec. 14	43	

NITROGEN CONTENT OF PULP WATER WASTE					
WASTE	Days of Composite	Untreated Waste		Treated Waste	
		Ammonia Nitrogen PPM	Organic Nitrogen PPM	Ammonia Nitrogen PPM	Organic Nitrogen PPM
Pulp Pasmier Water	Nov. 23	0.7192	17.08	0.0460	6.72
Pulp Pasmier Water	Nov. 28	0.0344	13.16	0.0976	11.48
Pulp Press Water	Nov. 30 thru Dec. 2	0.0384	12.32	0.0384	10.92

TABLE 7

ANALYTICAL RESULTS PILOT PLANT STUDIES BEET SUGAR PULP WATER WASTES

BRIGHTON BEET SUGAR FACTORY
GREAT WESTERN SUGAR COMPANY
BRIGHTON, COLORADO

FEDERAL SECURITY AGENCY
PUBLIC HEALTH SERVICE
ENVIRONMENTAL HEALTH CENTER
CINCINNATI, OHIO DECEMBER, 1949

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B

33. Waste Characteristics

This pulp waste water possessed characteristics typical of published process waste data. The average values of B.O.D. of 24 hour composite samples of screened Paenger and pulp press waters for the three test runs ranged from 1260 to 1450 ppm. The maximum values occurred during the test run conducted the third week of December. Volatile solids increased progressively throughout the campaign, the increase amounting to 28%. The influence of fine screening is evidenced by the relatively low suspended solids content of pulp waste water supplied to the pilot plant. See Table No. 8.

34. Settling Tank Retention

Actual retention in the pilot plant settling tank was studied by use of Fluorescein dye at two flow rates. The results of this study are shown graphically in Figure 6. These results indicate a definite tendency to short circuit with color appearing in the effluent in a period as short as eight minutes. Lime treatment produced a dense, rapid settling floc giving satisfactory clarification under apparent adverse settling conditions.

35. Fine Screening

The advantages of fine screening for pulp waste water were clearly demonstrated. It is possible that the efficiency of the link-belt vibrating screen would have been more accurately determined by examining influent and effluent for suspended solids rather than the indirect method employed. However, the potential recovery of five pounds (dry solids) or more of pulp per ton of beets sliced (See Table 4) suggests a means of reducing beet waste concentration at a profit. The benefit of fine screening should be investigated, when considering pulp waste water treatment, even though the waste may not contain beet tailings.

TABLE 8 - SUMMARY OF BOD AND SUSPENDED SOLIDS ANALYSES FOR EACH TEST RUN PILOT PLANT STUDIES OF PULP WATER WASTES

Test No.	Treatment	Waste Treated	Sampling Days	Average Chemical Dosage ppm	Inflow to Plant gpm	Sample 24-Hr. Composite	BOD 5-DAY 20°C Avg. ppm[b]	BOD 5-DAY 20°C Avg. Reduction Per Cent[b]	SUSPENDED SOLIDS Avg. ppm	SUSPENDED SOLIDS Avg. Reduction Per Cent	VOLATILE SOLIDS Avg. ppm	VOLATILE SOLIDS Avg. Reduction Per Cent
1	Lime Treatment	Combined Screened Pulp Faenger and Pulp Press Water With Tailings	13 10/17-11/7	600 CaO	11.9	Untr.	1258	22	668	92	1684	18
						Tr.	974		48		1420	
2	Lime Treatment		5 11/9-14	650 CaO	20	Untr.	1260	21	470	86	1928	27
						Tr.	974		62		1404	
3	Lime Treatment		3 12/16-21	820 CaO	15.7[a]	Untr.	1452	36	510	88	2249	31
						Tr.	928		60		1549	
4	Lime Treatment	Same as 1-3 Without Tailings	5 11/16-21	670 CaO	11.5	Untr.	1251	34	520	94	1911	35
						Tr.	797		30		1188	
5	Lime Treatment	Screened Pulp Faenger Water	4 11/23-28	690 CaO	11.4	Untr.	978	36	530	90	1626	28
						Tr.	623		54		1149	
6	Lime Treatment	Screened Pulp Press Water	5 11/30-12/5	820 CaO	10.7	Untr.	1708	26	420	89	2555	25
						Tr.	1308		40		1916	
7	Chlorine Treatment	Same as 1-3	6 12/7-14	50 Cl	10.5	Untr.	1206	8	585	30	2148	+ 10
						Tr.	1145		412		2342	

a. Considerable variation - 14.0 to 17.6 gpm.
b. Average of both labs. results.

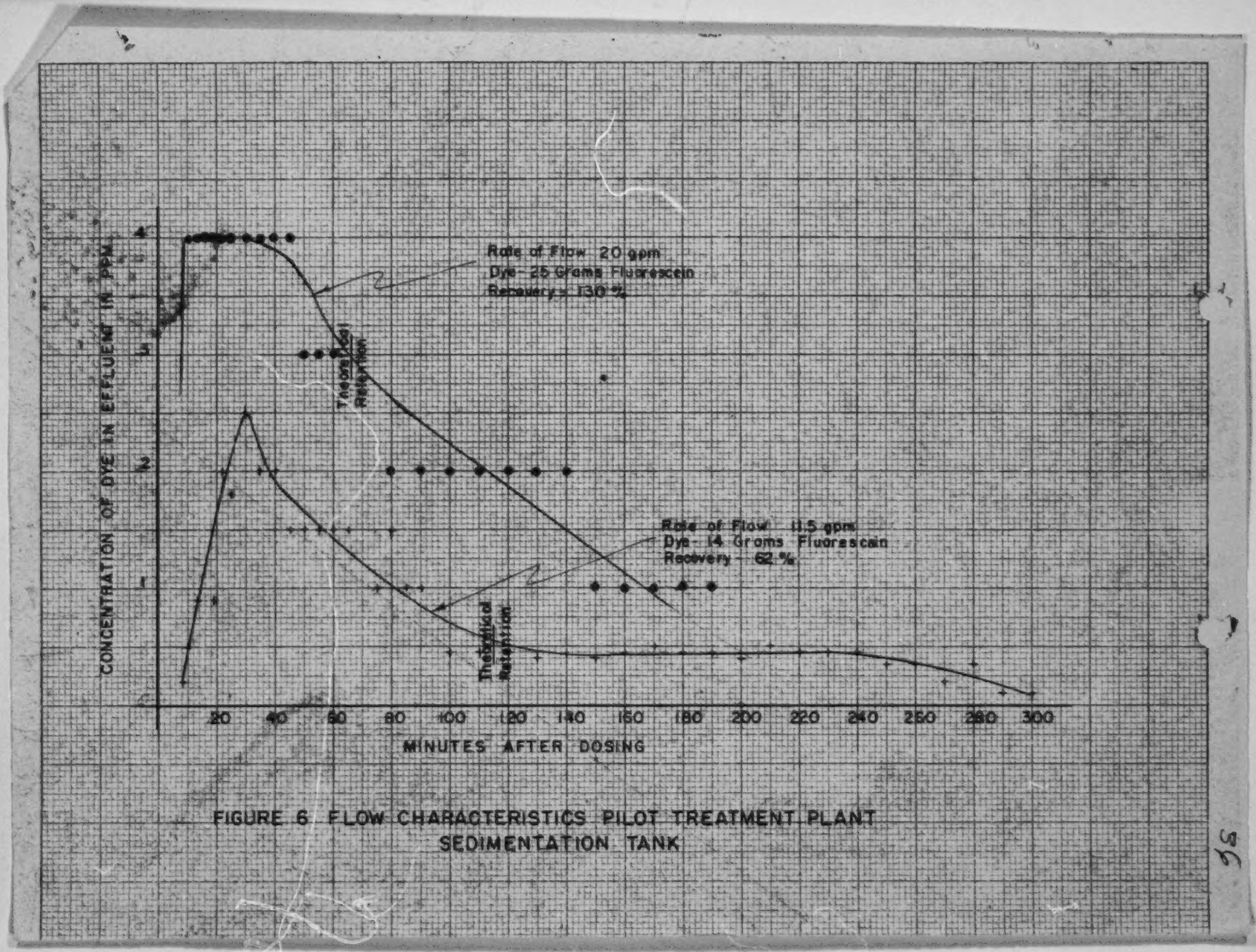

FIGURE 6 FLOW CHARACTERISTICS PILOT TREATMENT PLANT SEDIMENTATION TANK

36. Lime Treatment

Lime (CaO) treatment of Saenger water and pulp press water, at dosages of 430 to 700 ppm, with two hours sedimentation, removed an average of 92% of the suspended solids during the 13 day No. 1 test. Slightly higher suspended solids removal was accomplished when tailings were absent in test No.4 but this could have been due to systematic errors. Liberation of CO_2 by ignition in the solids determinations would influence volatile solids results for the lime treated waste.

Pulp press water was the most concentrated waste treated with dissolved solids approximating 2500 ppm and an average B.O.D. of 1770 ppm. Effective suspended solids removal was accomplished but the sludge produced contained only 3.7% solids. Press liquor is a waste to be reckoned with in any modernization and stream pollution abatement program. The highest B.O.D. reductions were reached during the last week of the campaign. Great Western Sugar data indicated a maximum removal of 48% for December 19. The average of all B.O.D. results for Test Run No. 3 showed 36% removal. The lowest average B.O.D. reduction occurred during Test No. 2 when theoretical retention was reduced to approximately one hour. During this five day period, the average removal was 21%. It is significant that extremely low B.O.D. reductions indicated by Public Health Service data were not confirmed by the Great Western Sugar Laboratory. (Table 7).

The reduction of non-sugar B.O.D., as computed and tabulated in Table 5, ranged from 48% to 76%. These values reveal that lime treatment is most effective in B.O.D. removal for a low-sugar (efficient extraction) waste.

Tailings were reported to contain 8.5% sugar which accounted for tests on pulp waste water with and without tailings.

The bacteriological work was very limited. The few results recorded in Table 6 show surprisingly rapid and effective destruction of thermophiles by 600 ppm lime treatment. The bactericidal effect of excess lime treatment for these wastes might well be further explored.

37. Chlorine Treatment

Favorable reports on research with chlorine, conducted in 1948 at an Ohio beet sugar factory, prompted preliminary tests with chlorine treatment of pulp water at the Brighton plant. The Brighton studies indicated chlorine, at a dosage rate of 50 ppm, to be a satisfactory bactericidal agent. The results obtained revealed chlorine, under the conditions tested, ineffective in removal of B.O.D. Two hours sedimentation (theoretical) following chlorine treatment reduced suspended solids 30% and gave a sludge containing 4% solids.

38. Sludge Characteristics

Sludge from lime treatment was a greenish-tan, viscous liquid ranging from 2.8% to 6.6% solids concentration and averaging about 5.5%. The sludge volumes and solids concentrations for various waste combinations are recorded in Table 9. Screened pulp press water had the least dense sludge averaging 3.8% solids. The volatile content of the sludge ranged between 60% and 65% being high from the presence of lime. No difficulty was anticipated in mixing this sludge with pressed pulp and drying as cattle feed.

TABLE 9 - SLUDGE VOLUMES FROM LIME TREATMENT OF PULP WASTE WATER

Waste	Dates Inclusive	Inflow to Pilot Plant in gpm	Sludge Volume Produced Per Cent	Waste Per Ton of Beets Gallons	Sludge Per Ton of Beets Gallons	Total Solids in Sludge ppm	Dry Solids in Sludge Per Ton of Beets Pounds
Pulp Waste Water with Tailings	10/17-11/7	11.9	1.90	437	8.3	54,000	3.7
Pulp Waste Water with Tailings	11/9-11/14	20	1.78	437	7.8	75,000	4.8
Pulp Waste Water Without Tailings	11/16-11/21	11.5	2.40	437	10.5	57,000	5.0
Pulp Press Water	11/30-12/5	10.7	4.53	180	8.1	38,000	2.6
Fenager Water	11/23-11/28	11.4	2.15	240	5.1	59,000	2.5
Pulp Waste Water With Tailings	12/16-12/19	14-17	2.40	437	10.5	59,500	5.2

39. Reclamation and Reuse

By-product recovery and reuse of waste waters are the first approach to any trade waste problem. The technical literature cites European practices of reusing pulp water and reports satisfactory results. The American beet sugar industry has, in general, looked with disfavor on reuse. Some United States beet sugar plants have recently been operated with pulp water and pulp press water being treated and returned to the diffusion battery water supply.

Potential advantages claimed are:

a. Recovery of sugar and pulp.

b. Conservation of heat.

c. Reduction in fresh water required.

d. Elimination of waste from these sources.

The practice of reuse of pulp water and pulp press water introduces some operation problems and possesses some inherent disadvantages. These reported include:

a. Treatment necessary to control thermophilic bacteria which otherwise would cause odors, conversion of sugar, and gas binding in the diffusors.

b. Alleged inefficient extraction of sugar from the beets attributed to increase in total solids in the diffusion water.

c. Interference of impurities on sugar crystallization and resultant yield.

d. Corrosive effect on plant equipment when returned water is slightly acid.

e. Increase of non-sugar pollutants in other factory wastes such as lime cake and the Steffens waste.

The greatest single impelling force for reusing pulp water and pulp press water is the elimination of these waste sources at a minimum cost. Success of this proposal will be dependent on whether or not reuse can be practiced without deleteriously effecting the beet sugar refining process.

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It is desired to express appreciation to the management and personnel of the Great Western Sugar Company, all of whom were generous in their cooperation and assistance in the conduct of this experiment. Particular gratitude is due Mr. Nees and Mr. Bennett for their personal direction and supervision of the project and to Mr. Jones and the operating staff for construction and maintenance of the equipment.

C. N. McDermott
Asst. Sanitary Engineer.

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APPENDIX A

Description of the Process

The process and equipment employed at the Brighton Beet Sugar Factory of the Great Western Sugar Company for the extraction of sugar from sugar beets is described briefly below. Particular attention is given to the production of pulp faenger and pulp press water.

The process of purification of the extracted juice and the separation of the sugar crystals is not discussed.

Reference is made to a pictorial line diagram of the process, Figure 7, and to the water utilization diagram Figure 8.

40. Harvest and Storage of Beets

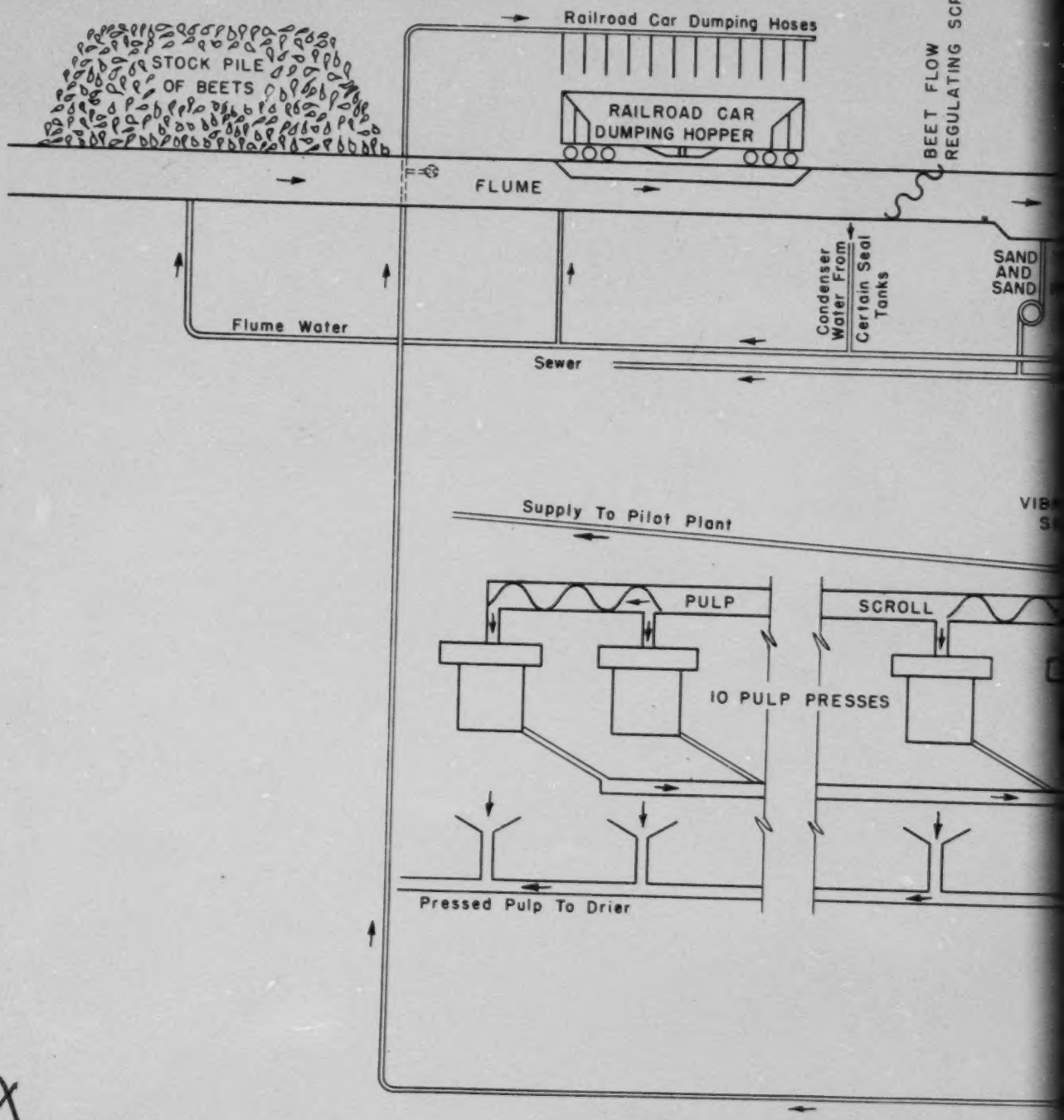
Beets are harvested over a period beginning near October 1 and extending to mid-November. It is necessary due to climatic conditions to have all the beets harvested by mid-November. Those beets not loaded directly to railroad cars and delivered to the process are stored in piles near railroad sidings or at the factory.

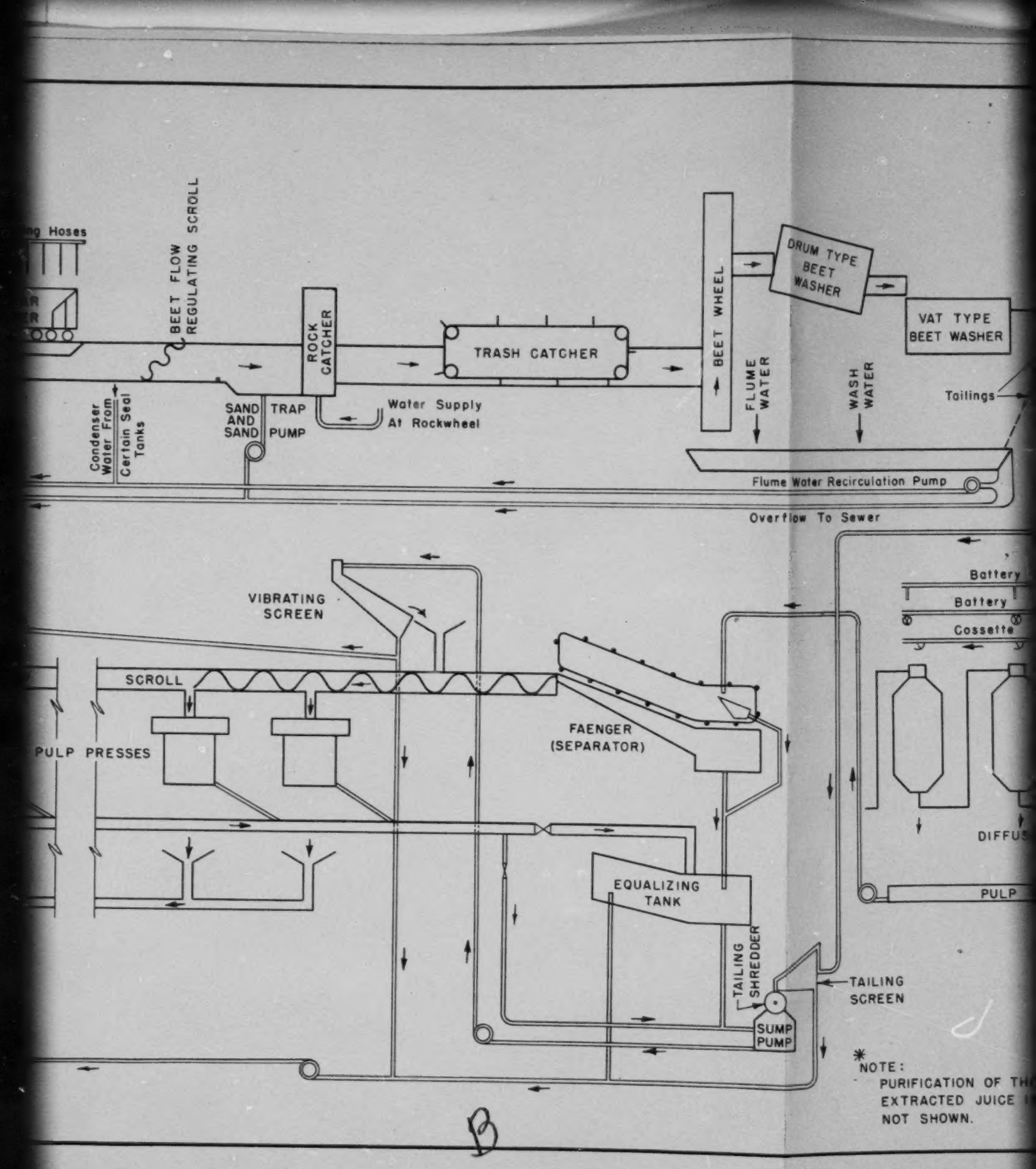
41. Fluming

Beets are conveyed from the railroad cars and the factory storage area to the factory by means of water flowing in a flume. Devices for removing rocks, beet tops, and floating debris operate along the flume. The flume not only serves the purpose of transporting the beets but also helps remove the dirt from them.

42. Washing

The beets are lifted from the flume water and delivered to the washers


Railroad Car Dumping Hoses
STOCK PILE OF BEETS
RAILROAD CAR DUMPING HOPPER
BEET FLOW REGULATING SCROLL
FLUME
Condenser Water From Certain Seal Tanks
SAND AND SAND
Flume Water
Sewer
Supply To Pilot Plant
PULP
SCROLL
10 PULP PRESSES
Pressed Pulp To Drier


ng Hoses
BEET FLOW REGULATING SCROLL
ROCK CATCHER
TRASH CATCHER
BEET WHEEL
DRUM TYPE BEET WASHER
VAT TYPE BEET WASHER
FLUME WATER
WASH WATER
Tailings
Condenser Water From Certain Seal Tanks
SAND AND SAND TRAP PUMP
Water Supply At Rockwheel
Flume Water Recirculation Pump
Overflow To Sewer
VIBRATING SCREEN
Battery
Battery
Cossette
SCROLL
PULP PRESSES
FAENGER (SEPARATOR)
DIFFUS
EQUALIZING TANK
PULP
TAILING SHREDDER
TAILING SCREEN
SUMP PUMP
*NOTE:
PURIFICATION OF TH
EXTRACTED JUICE I
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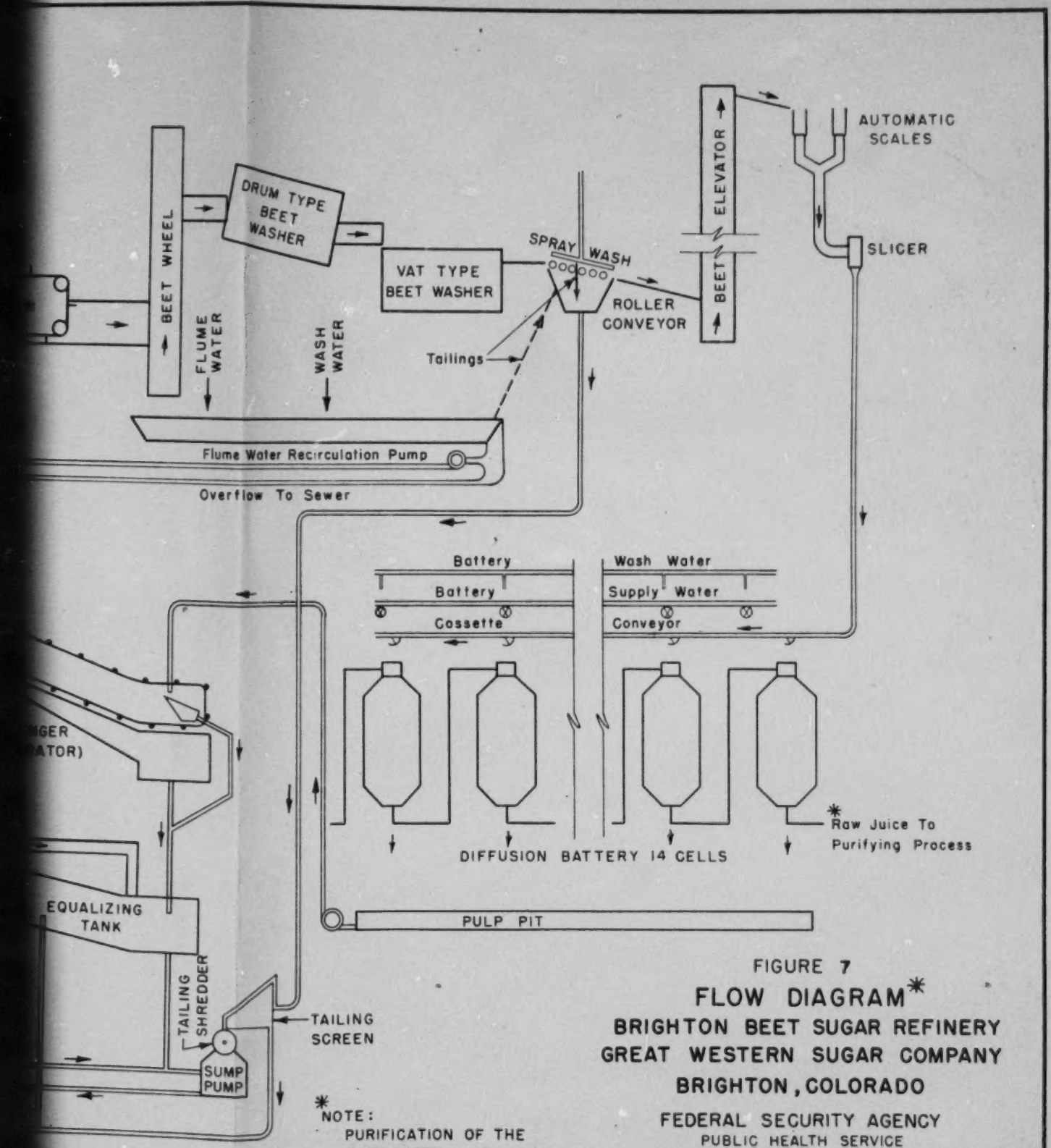


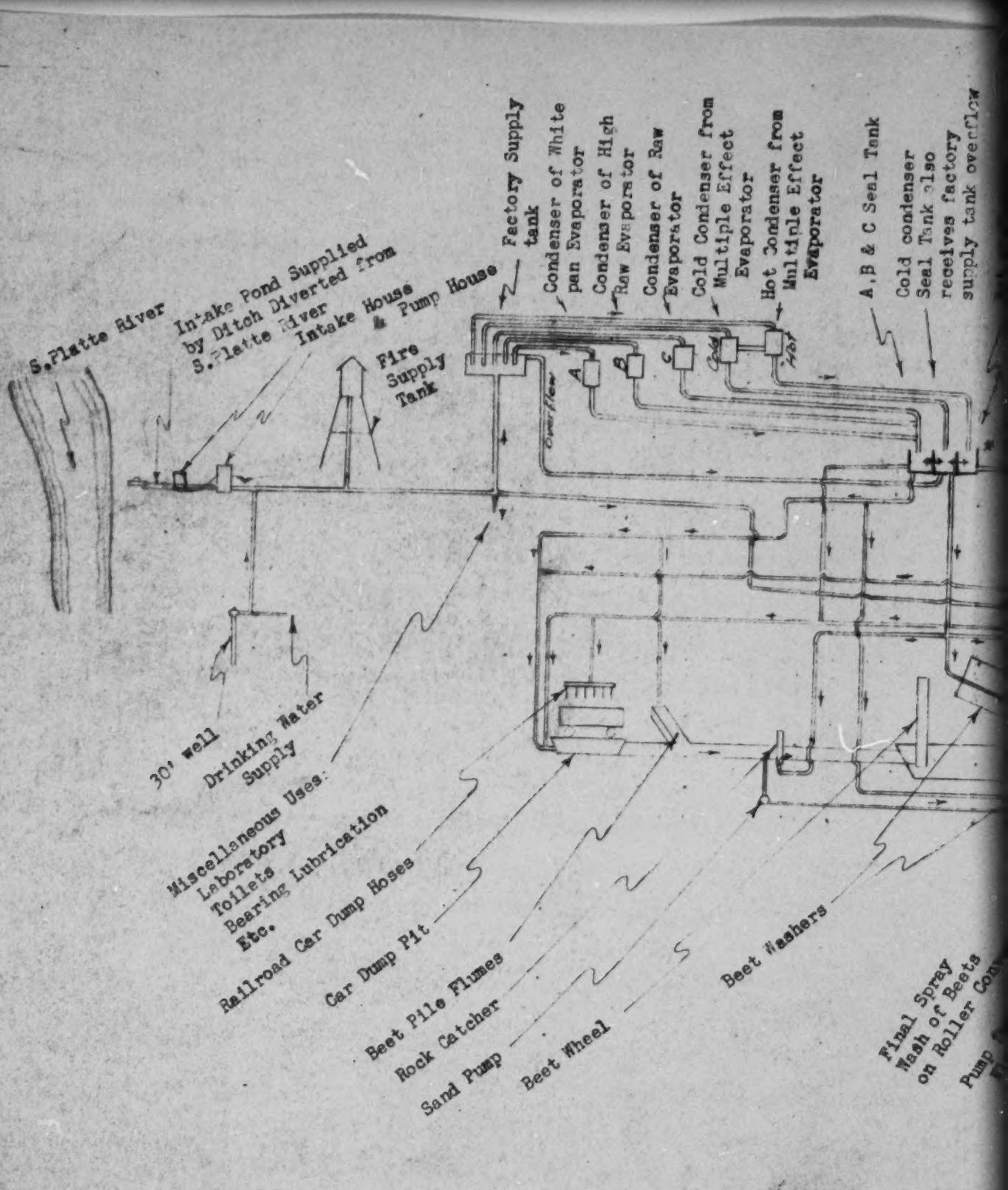
FIGURE 7

FLOW DIAGRAM*

BRIGHTON BEET SUGAR REFINERY
GREAT WESTERN SUGAR COMPANY
BRIGHTON, COLORADO

FEDERAL SECURITY AGENCY
PUBLIC HEALTH SERVICE
ENVIRONMENTAL HEALTH CENTER
CINCINNATI, OHIO DECEMBER, 1949

*NOTE:
PURIFICATION OF THE EXTRACTED JUICE IS NOT SHOWN.



Symbols

o - pump

* Seal tanks interconnected by pressure o
gates so that other seal tanks will sup
seal tank in which water level becomes l
Ordinarily the interconnections are clo

Seal tanks interconnected by pressure closed gates so that other seal tanks will supply any seal tank in which water level becomes low. Ordinarily the interconnections are closed.

B

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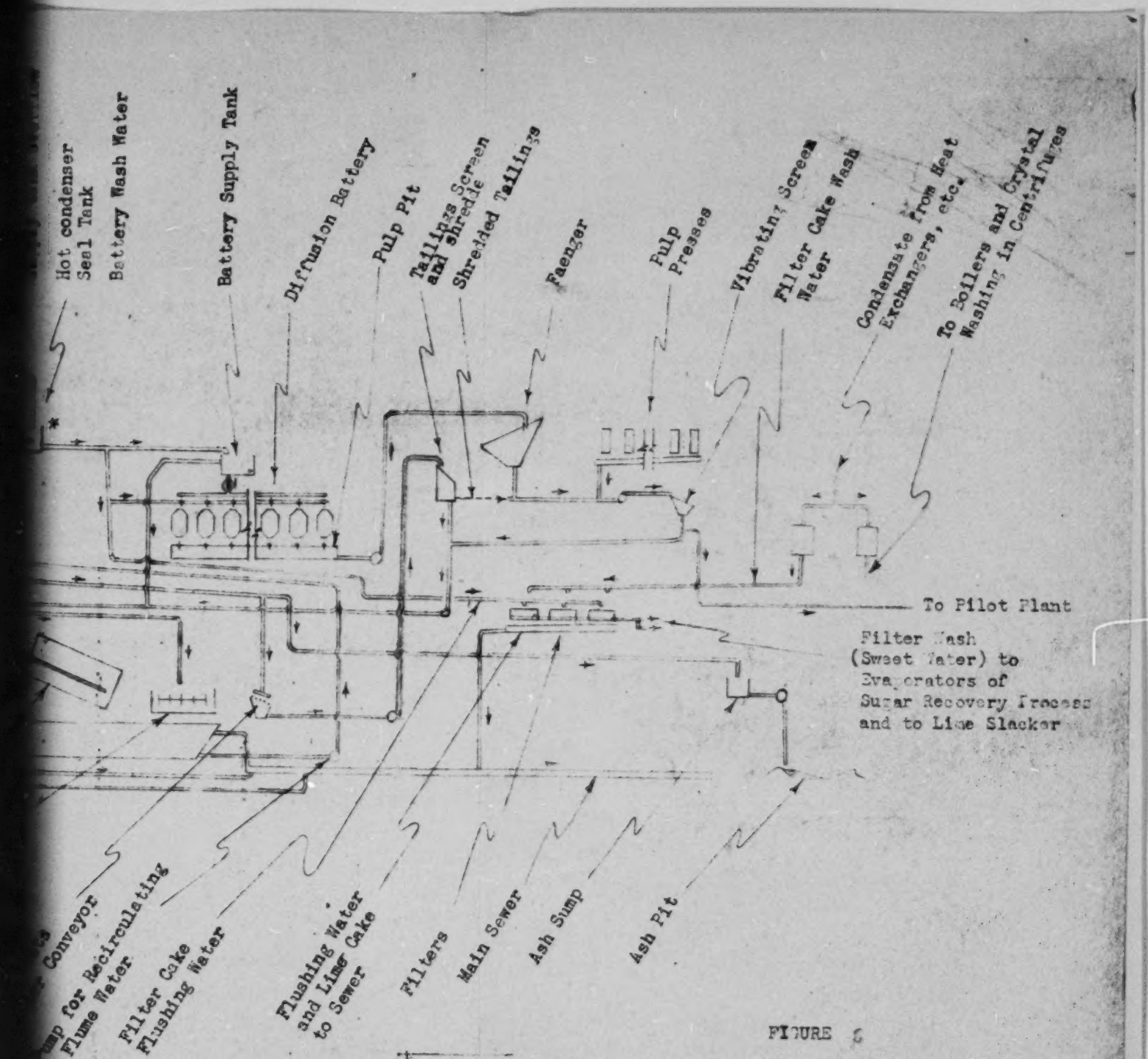

FIGURE 6

WATER UTILIZATION DIAGRAM

BRIGHTON BEET SUGAR FACTORY
GREAT WESTERN SUGAR COMPANY
BRIGHTON, COLORADO

FEDERAL SECURITY AGENCY
Public Health Service
Environmental Health Center

Cincinnati, Ohio December, 1949

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by means of the beet wheel. The Brighton factory is equipped with two types of washers, one being a revolving drum spray type, which was in the experimental stage of development, the other being a vat type washer with continuous overflow. The experimental washer was used only the latter part of the season, for a time in parallel with the vat type, and for a time in series.

The beets discharge from the washer to a roller type conveyor and spray wash. Small pieces of beets, beet tails, roots, and leaves which have been broken from the beets pass between the rollers and are collected with the spray wash water in a hopper below the conveyor. To this hopper is shoveled other pieces of beets, beet tails, roots, and leaves which are screened from the washer waste water and flume water. The solid material is known as tailings. Disposal of the tailings and spray rinse water will be described later in this appendix.

43. Slicing

The washed beets are elevated to batch type weighing scales from which they drop to the slicers. The slicers cut the beets into long, slender V-shaped slices known as "cossettes." The cossettes are carried on a belt conveyor to the diffusion battery.

44. Diffusion

The Brighton diffusion battery consists of fourteen cylindrical steel tanks of a capacity of about 240 cu. ft. or about five tons of cossettes each. The cells are interconnected by means of an intricate piping system, with a heating unit in the system between each cell. The cells are filled with

cossettes in rotation and pulp is discharged from each cell in turn. Fresh battery supply water at about 50 to 55° C enters first the cell containing pulp which has been longest in the system and from which, therefore, most of the sugar has been extracted, and after passing through the other cells in series, leaves by way of the cell which was last filled with cossettes, which thus contain most of their original content of sugar. The system is thus one of counter-current extraction. Three cells are usually out of circulation for dumping and filling operations. The diffusion juice is heated to a maximum of 80° C in the battery. The liquid drawn off from the last cell in the series is known as raw juice, reference is made to other publications for a description of the process of recovering sugar from the raw juice.

Operation of a cell at the time the cell is dumped is as follows: When a cell has been completely diffused and is ready to dump it will have been receiving fresh battery supply water for a time sufficient to completely force forward in the battery the juice formerly filling the cell. The cell is isolated from the circulating systems and the contents of the cell dumped through a quick opening gate in its bottom. Adhering pulp is flushed from the interior of the cell by battery wash water from high pressure wash hoses.

The spent cossettes, water contained in the cell when it is dumped, and battery wash water are discharged into a trough extending under the entire length of the battery. This trough is known as the pulp pit and leads to a pump sump. The cells and pulp pit are shown in photographs, Figures 9 and 10.

45. Separation of the Pulp

The pulp suspension is pumped to the drier house where it is discharged to a special screen called a fasnger, illustrated in Figure 11. Considerable water drains from the pulp through the screen. This water is known as fasnger

water. The pulp passes from the screen to a scroll conveyor which carries the pulp to rotary pulp presses. The pulp presses squeeze from the drained pulp an additional flow of waste water known as pulp press water.

The faenger water drains to an equalizing tank which in turn supplies the vibrating screen pump sump. Pulp press water flows directly to this pump sump.

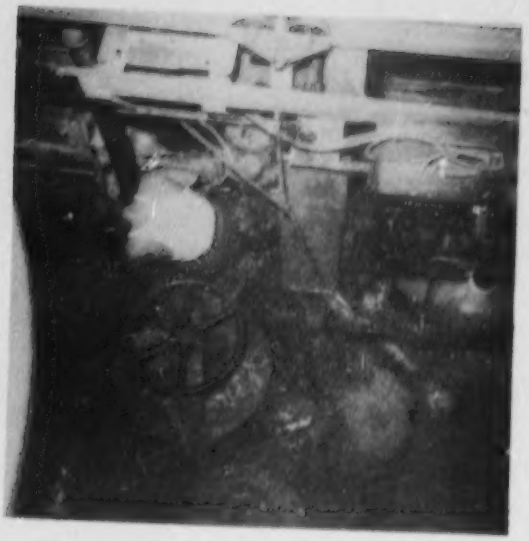

Figure 9. View of the top of two cells of the Diffusion Battery. Top of cells project just above working floor. The cell on the right side is being filled with cossettes from the belt. The top of the cell is partially covered in the photo by the cell filler, which is a device for distributing the cossettes as they fall into the cell. This device is moved along on an overhead track from cell to cell. Cossettes are seen hanging on the edges of the cell opening and spilled on the floor beside the cell. The cell on the left side is in the process of being dumped. The workman is directing the battery washing hose in the cell.

Figure 10. Pulp pit, showing bottom gates of cells of the diffusion battery. Pulp and pulp water fall from the gates to the V-shaped trough (pulp pit. The suspension flows down the trough to the pump.

Figure 11. The pulp f:nger for screening pulp from the pulp water. This view shows only a part of the device, the perforated metal screen up which the pulp is dragged by the cross bars.

Figure 12. Link-belt vibrating screen. Pulp water is shown pouring from the distributor and the recovered pulp is seen moving down the screen.

46. Tailing Screen

The suspension of tailings and spray rinse water, the source of which was previously discussed, is pumped to a screen in the drier house. The tailing screen normally discharges the tailings to a tailing shredder. The tailing shredder is a hammer mill used to crush the tailings in order that they may be dried with the pulp. The shredder was located above, and discharged the shredded tailings into the vibrating screen pump sump.

47. Vibrating Screen

The fine pulp passing the fasnger and presses together with the shredded tailings are screened from the fasnger and pulp press water on a 30 X 40 mesh vibrating screen. The material removed on the screen returns to the scroll feeding the pump presses. The screen is shown in Figure 12.